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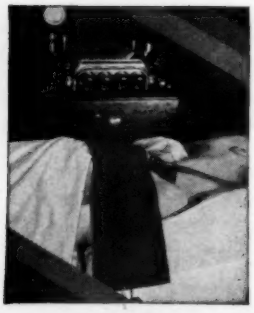

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THE BIOLOGICAL EFFECTS OF THE ULTRAVIOLET RAYS AND INVESTIGATIONS AS TO WHAT PART OF THE SPECTRUM THEY LIE IN*

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FINSEN INSTITUTE, COPENHAGEN

As I stated in a preceding paper, it is the custom to say that the effects of light on the human organism are divided into different kinds, namely: a heating effect and a chemical effect. All that is not a heating effect is called a chemical effect. Disregarding the infra-red rays, which at all events seem to play their part as heating factors only, circumstances are so that, when the heating of the animal organism is spoken about, the heating effect of the light bath is essentially connected to the long wave, luminous rays, whereas the chemical effect is connected with the short wave ultraviolet or possibly violet rays. That the heating effect of the luminous rays is of a specific kind, which possibly might be of a therapeutic importance, was therefore the main subject of the preceding paper.

I now wish to say something about the so-called chemical effect of light on the organism. To be complete I would remind you at the beginning that this distinguishing between the heating effect of the luminous and the chemical effect of the shorter wave rays only applies when the irradiation of the animal organism is spoken of. In the vegetable kingdom this difference does not apply at all. Here it is specially the luminous rays which have the specific, extremely important chemical light effect which by aid of the chlorophyl renders possible the assimilation of carbonic acid by the plants and thus really maintains all organic life on this world. Similar phenomena are, therefore, not known with regard to the animal organism. So that, for the present, we must assume that the chemical effect of the luminous rays is of secondary importance. If the naked surface of man is exposed for some time to irradiation by one of the sources of light which are generally employed for a therapeutic light bath, namely: the sun, the carbon arc light or the quartz mercury light, it will be observed some time after the cessation of the irradiation that an erythema appears on the skin which is more or less severe according to the intensity of light employed. You all know that this erythema is carried by the so-called chemical action of the light, and is due to the ultraviolet rays. In a later paper I shall speak about our investigations on light and rickets. It is known that the effect with rickets is also due to the ultraviolet rays. Thus we have here two certain effects of these rays: the erythema effect and the therapeutic effect with rickets. It is possible, perhaps even reasonable that the erythema effect is in connection with the therapeutic effect which we notice the light bath has on certain diseases, but we do not yet know anything definite about this. In reality rickets and the related diseases, tetany and the like, are the only diseases with

*Read at the seventh annual meeting American College of Physical Therapy, Chicago, Oct. 18, 1928.

which we know with certainty that the therapeutic effect of the light bath is due to the ultraviolet rays.

At the extraordinarily great spreading, which the light bath justly, but surely also in many instances unjustly has found as a therapeuticum, it is naturally of the greatest importance that we understand what biological effects the various ranges of rays can have. The greater our knowledge in this direction, the greater also the possibility of utilizing these rays in therapy and in utilizing them in a rational manner.

A great step forward in this direction was made by Hausser and Vahle whose work from 1922, later on supplemented by work in 1927 which justly caused attention. They examined, namely, in these works and explained the dependency of the erythema from the wave length of the light. They employed for this a powerful spectral apparatus with quartz lenses and quartz prisms, and by these means examined the effect of the mercury light's various spectral lines on their own skin and that of others. They thereby obtained this diagram for the erythema effect of the rays.

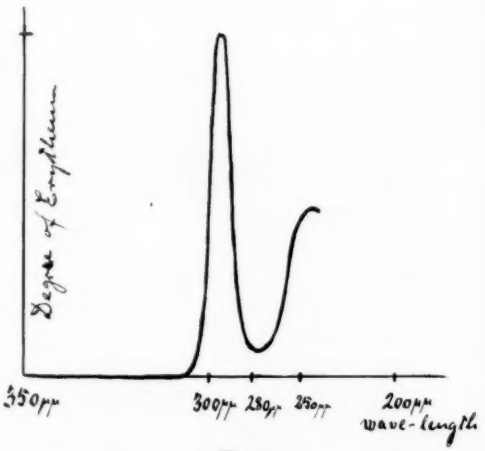


Fig. 1
Curve of Erythema (Hausser and Vahle)

Accordingly it is the rays of about 300μμ which have by far the greatest effect. The curve rises rapidly here and drops as quickly again. According to the latest investigations of 1927 there also appears a small rise at 260μμ. Later I myself made experiments similar to those of Hausser and Vahle and can support their observations entirely. In order that the importance of this may be firmly established in your minds, I show you here 3 diagrammatical spectra of sunlight, carbon arc light and quartz mercury light.

You will see that the ultraviolet rays extend very unevenly long into the spectrum. The ultraviolet part of the spectrum of the sun reaches

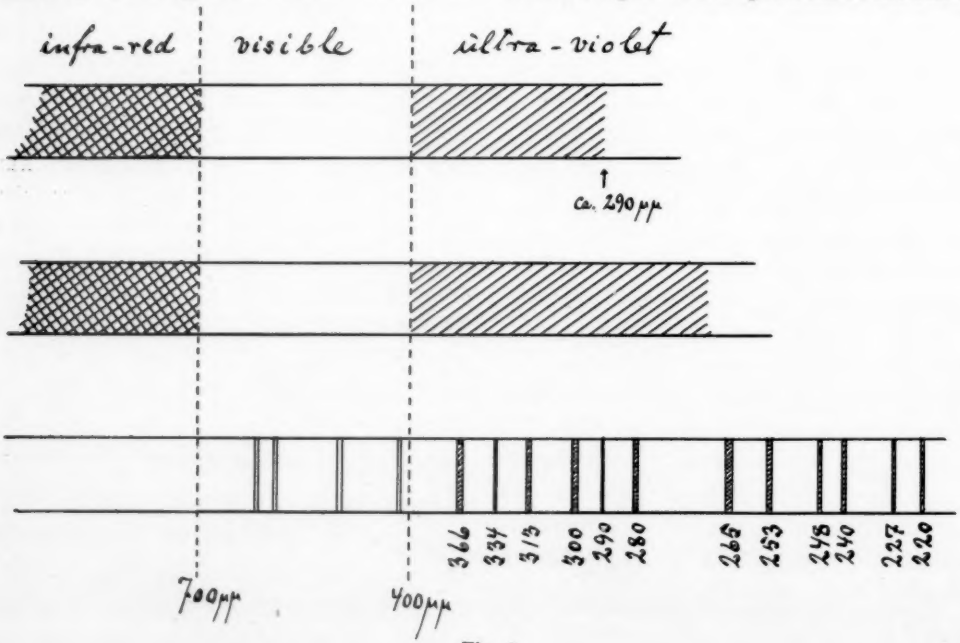


Fig. 2

to about 290$\mu\mu$, that of the carbon arc light extends somewhat farther, and that of the quartz mercury light a good distance still farther. The capacity of producing erythema lies here about 300$\mu\mu$ and extends only very little farther to the sides of this. Therefore one just gets in the unfiltered sun light the strongly erythema producing rays.

Hausser and Vahle's work has, as I have already said, excited much attention. Chiefly in Germany it was thought that it was now proved with certainty, where the therapeutic effect lay in the ultraviolet spectrum. It was taken as granted that the erythema effect had to be in relation to the therapeutic effect, and it was at certain points even emphasized that all biological reactions, namely the biological reactions connected with the chemical action of the light, had their maximum in this ultraviolet range of rays from 313$\mu\mu$ to 290$\mu\mu$. Peemoller and Dannmeyer in Hamburg, for example, named this range of rays the Ra-range because they thought it was exclusively these rays which were effective on rachitis. We very soon showed at our laboratory that this was incorrect. With experimental rickets one can obtain an excellent effect with rays far out in the spectrum. But on the whole, this discussion on where in the ultraviolet spectrum lies the therapeutic effect, was the cause that I investigated more closely where in the ultraviolet spectrum lay the biological effect of the rays. The ray emitters which we use in therapy have, as you have seen, very different ultraviolet spectra, both as regards their spread and their strength at the various points. It is therefore quite necessary to know how the various wave lengths act biologically. It certainly is far advanced before we can explain, how the ultraviolet rays act therapeutically, but the more biological effects we can have investigated and the range of action thereof ascertained in the spectrum, the more we shall be entitled to feel that we are on the right way to attain our aim.

A long series of different light biological reactions are spoken about, reactions which may be assumed in one or another way to be in connection with the therapeutic action of the ultraviolet rays. Beside the erythema producing property of the light the following may, for example, be mentioned:

The hemolysing property on the red blood corpuscles.

The property of killing animal cells, for example, the bacteria killing property, which plays an extraordinary great hygienic part and its paramaecie killing property.

The property to coagulate albumin.

The property to convert oxhemoglobin into methaemoglobin. Besides these reactions I have also examined the phototropic property of the light, (i. e.) its property to influence plants to inflect towards the light: This I have examined its property to increase the oxygen metabolism. Many other biological reactions could perhaps also be enumerated, but, for the present, I have restricted myself to examine those named, beside those previously mentioned: the property of light to have a curative effect on rickets.

If we should speak of, how great the biological effect is at a given part of the spectrum, it is naturally necessary to know how great the intensity of radiation is at those parts of the spectrum of the ray emitter which is to be used. The principle for the investigations, that are spoken about here, is first to examine how much radiant energy of the various wave lengths will be necessary to produce the desired biologic reaction. So also Hausser and Vahle did at their examination of the erythema curve. They measured the energy per time and square unit in the lines of the spectrum and examined how much energy in the various lines was required for producing erythema. Their spectral apparatus was of a rather simple design. The apparatus which we shortly after had designed for our use, has allowed us as accurarate a test arrangement as Hausser and Vahle had. When we got our special apparatus three years ago, it was probably the only one of its kind in the world. Monochrameters with a strength so great in the ultraviolet have probably never been built before. Owing to this we have therefore, also been able to make certain observations which no one previously has been able to make by other means.

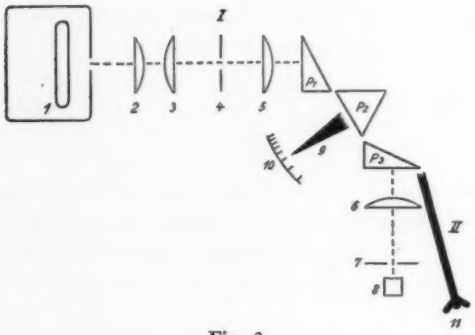


Fig. 3

Subsequently, after we had commenced to publish investigations with this apparatus, other laboratories obtained similar apparatus.

You see here the diagrammatical picture of this apparatus. It consists of a system of prisms and lenses and is so designed that only the spectral line wanted, may be made to emerge from the slit (7). For this purpose all lenses are independently displaceable and may be adjusted after a scale on the apparatus, which indicates the position of the lenses at all wave lengths. The system of prisms may be displaced by means of a turning rod (ii).

Here you see a photograph of the apparatus with the prisms bared and the lamp removed from the lamp casing. The distance from the lamp casing to the lowermost prisms is about 100 cms. The energy at the lines is measured by aid of a thermocell from Kipp and Zonen, and mirror galvanometer connected with the same.

The first I examined with this apparatus, was the hemolysing capacity of light. I employed for this a blood agar method indicated by Hausman in Vienna, which he used for other blood examinations. The blood agar is prepared by putting two or three drops of washed blood corpuscles, centrifuged down, into 5 cubic cm.

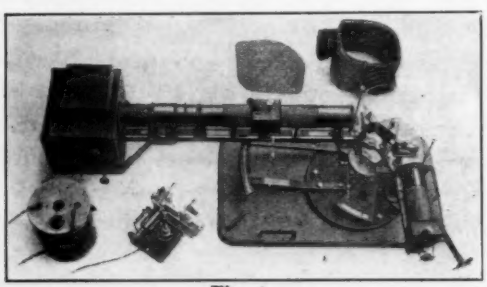
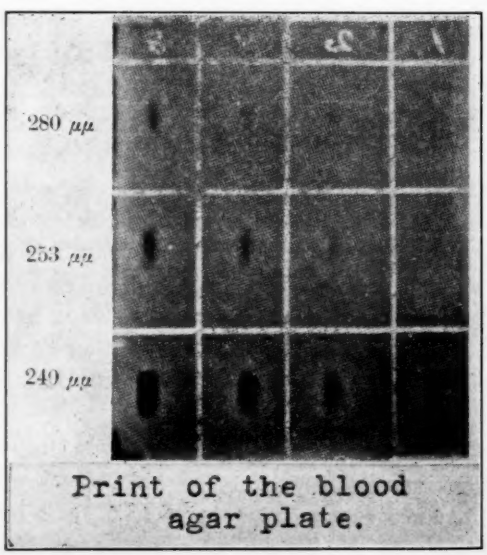


Fig. 4

agar in physiological salt solution. The agar was poured out into a layer of about 2 mm. high on to a glass plate. When the agar had set and formed a quite opaque red layer, it was placed before the exit slit of the spectral apparatus and irradiated from here at various places with the various lines. The various places for the irradiation had previously been marked on the back of the glass plate, the latter being divided by means of a skin pencil into panels.

A hemolysis, caused by irradiation, will of course show that, corresponding to the spot irradiated, there appears a clearance in the plate which becomes more or less transparent. It requires some time for the coloring matter of the blood to diffuse in the agar and therefore the reaction is not immediately observed. It may last up to about 20 hours before it is most distinct. In the meantime the plate is kept in the dark. Here you see a print of an agar plate with hemolysis spots. At this experiment I irradiated with the ultraviolet lines 280 $\mu\mu$,, 253 $\mu\mu$ and 240 $\mu\mu$. The same quantity of energy was employed at the three lines. In the first three vertical panels eight times the energy was employed as in the last three panels. In the next three, four times and in the one but last, twice the energy as in the last panel. The black marks in the panels indicate the hemolysis, which,as you see, is given in different degrees. The effect is for



Print of the blood agar plate.

Fig. 5

the same quantities, very different at the various lines. It is directly obvious from this one experiment that the line 240 $\mu\mu$ lying far outside in the spectrum is far more hemolytically effective than any of the other lines. You see thus that, as there is the same degree of hemolysis in the first panel of 280 $\mu\mu$, in the second panel of 253 $\mu\mu$ and in the fourth panel of 240 $\mu\mu$, one can by this experiment, conclude that 240 $\mu\mu$ has here acted four times as powerful as 253 and eight times as powerful as 280 $\mu\mu$. I have made a series of such experiments whereby I have been able to find a numerical expression for the difference between the hemolysing powers of the various lines. If I call this power at line 313 "1", I have by these experiments found the figures which you see here.

You will see by the average figures that there is a rise in the effect, the farther we pass out into the ultraviolet; by far the most powerful is 240, as appears from this curve.

Where the wave length is plotted out on the abscissa axis and the hemolysing power on the ordinate axis, the effect rises evenly out through the ultraviolet, but rises suddenly and violently at 240 $\mu\mu$. The curve has, as you see here, quite a different course than with Hausser and Vahle's erythema curve, and this alone is sufficient to show that it is quite wrong to say that all biological chemical effects of light should follow the same line as the erythema curve.

With light hemolysis there is probably a destructive effect on the lipoid membrane of the blood corpuscles. It is probably the lipoid

FIG. 6

Experiment:	No. 1	No. 2	No. 3	No. 4	No. 5	Ave.
313	—	—	1	1	1	1
300	1.8	1.8	1.4	2	2	1.8
280	10.8	10.8	4.3	8	8	7.8
253	13.5	13.5	10.8	16	16	14.1
240	—	—	—	128	64	96

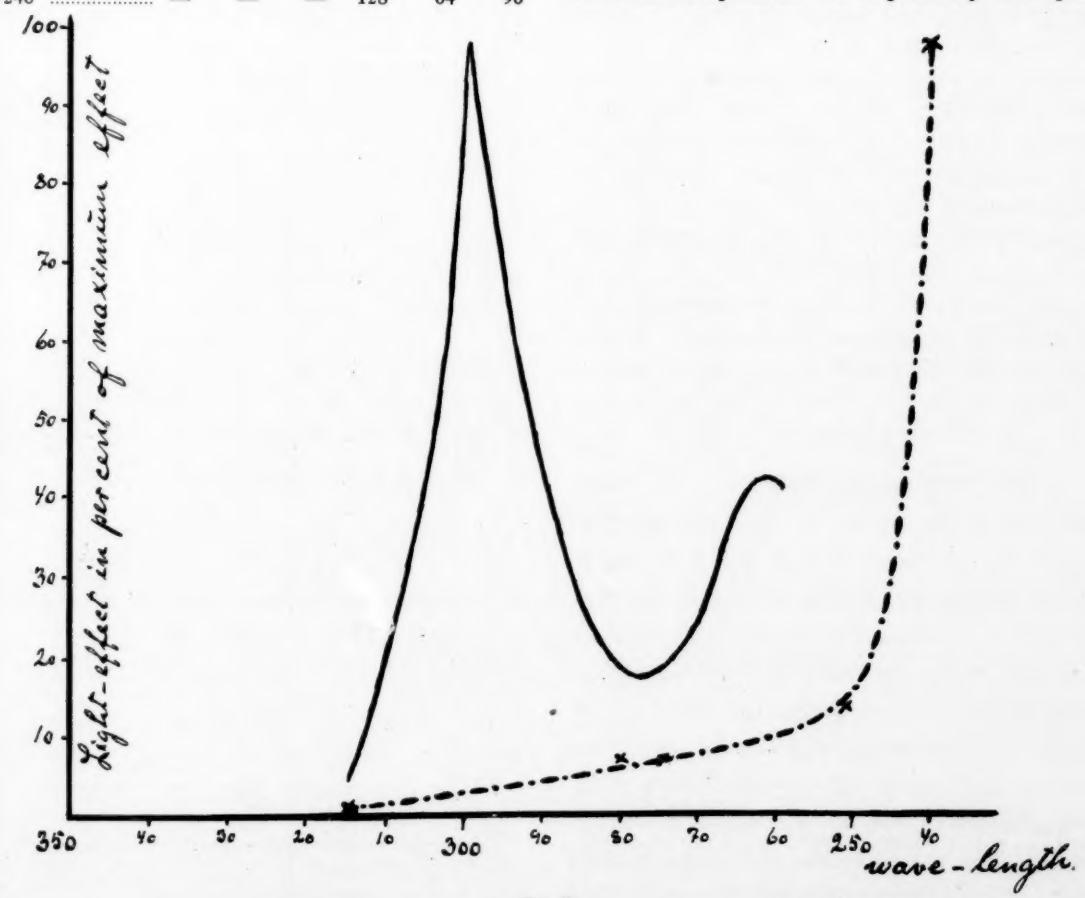


Fig. 7

———— Curve of Erythema—Haesser and Vahle. — - — - — Curve of Hemolysis.

molecule which is here destroyed or changed. An effect of light on the albumen molecule is also known. As I have mentioned before we have measured the capacity of light to coagulate albumen. In investigating which rays in the spectrum here are the most effective, proceeded in a manner quite corresponding to the hemolysis tests, in employing an agar method. I dissolved a fresh hen's white of egg which was filtered through gauze, in an agar solution and poured the solution to set on a glass plate. As before I divided the glass plate into panels and irradiated it close to the slit for increasing lengths of time with the various lines. If there appears any coagulation, it will appear immediately after cessation of the irradiation as a more or less clouding of the spot irradiated, while the albumen agar solution is otherwise fully clear and transparent. It is a reaction which is very difficult to obtain, and, although the agar plates which I employed had been prepared in the same manner, they seldom showed the same sensitiveness. There I have only been able to compare the results which I obtained with the same plate directly with each other. If I always speak of the effect of an arbitrarily selected line 265 $\mu\mu$ equal to 100, I can in the individual experiments find the effect of the other lines in proportion thereto and thus finally compare the various experiments with each other and find an average figure for the effective power of each line as to the coagulation of albumen. You see here on this table such a calculation for six experiments.

In the first column stand the lines examined, and in the second the energy proportions found between the lines. In the first column for the individual experiments stands the time in minutes I had to irradiate to obtain coagulation, and in the two next the relative power of effect of the lines, of course, calculated as the reciprocal value of the duration of irradiation and the light energy. In the last column is the average effect of the various lines at all experiments. You see here, that the effect is absolutely the greatest with two ultraviolet lines 265 and 253$\mu\mu$ lying far out, while the effect from here drops to both sides, as it is better

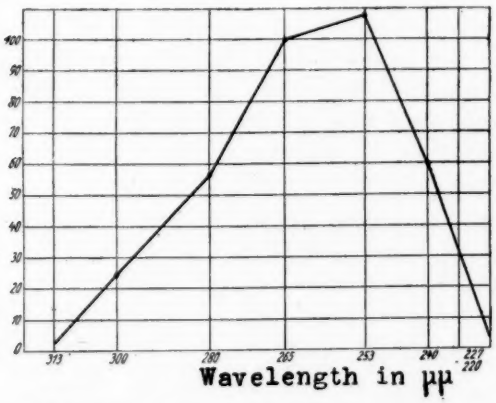
THE ALBUMEN COAGULATING EFFECT OF THE LINES

Datum:		15. III			16. III			17. III			7. IV			8. IV			9 IV.			Average
Line	Proport. of Energy = E	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	Coagul. in Min. = T	Rel. Eff. $\frac{10}{T-E}$	Rel. Eff. 100 at 265	
313 $\mu\mu$	2.8	78	0.05	3	32	0.12	2	32	0.12	5							64	0.06	3	3
300 $\mu\mu$	1.8	22	0.25	13	5	1.1	10	16	0.35	14							16	0.35	28	25
280 $\mu\mu$	0.65				7	2.2	20	16	0.95	38							16	0.95	76	57
265 $\mu\mu$	1.0	5	2.0	100	$\frac{53}{60}$	11.5	100	4	2.5	100	4	2.5	100	4	2.5	100	8	1.25	100	100
253 $\mu\mu$	1.1	3	3.3	165	$\frac{80}{60}$	7.5	68	4	2.3	92										108
240 $\mu\mu$ 220 $\mu\mu$ 227 $\mu\mu$	0.25 0.25	75	0.53	27				32	1.25	50				32	1.25	50	32	1.25	100	59
																	64	0.06	3	3

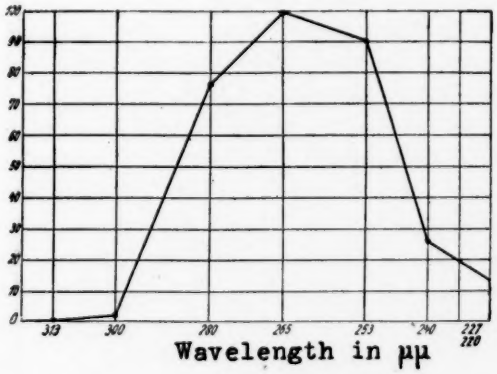
seen from the curve plotted after the figures, which curve has again a quite different form from the hemolysis curve which you just have seen.

Another light reaction which is probably also an albumen reaction is the power of light to convert oxyhemoglobin into methemoglobin. I have also examined the process of this reaction as in the preceding experiments by the agar method. I dissolved red blood corpuscles washed in distilled water and added the clear red solution to a solution of agar, and poured the whole in a quite thin layer onto a glass plate, which was irradiated in the same manner as the previous plates in panels. The agar plates before the irradiation shall be clear, transparent, and bright red. The formation of methemoglobin shows itself by a dark dirty discoloration of the irradiated part. When it appears it is immediately seen after the cessation of the irradiation. You see here on this table the result of a few experiments on the power of light to form methemoglobin where the calculation has been performed in quite the same manner as in the preceding experiments on the coagulation of albumen. Also here, as it appears from the last column, the maximum power is at line 265, whence the effect drops to both sides, as you also see on the curve formed by these figures.

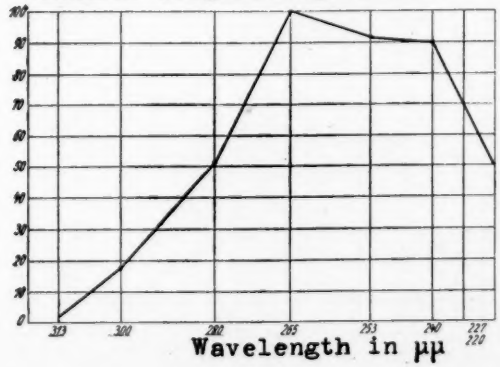
If you compare this curve with that of the albumen coagulation you will notice a considerable likeness between them. They both rise from 313 $\mu\mu$, both have their maximum about at 265$\mu\mu$ and thence both drop again. Probably they both show to a certain degree the effect of light on the molecule of albumen, and the small differences you see in the curves, are apparently due to faults in the experiments, which with such experiments, are unavoidable, as these to a high degree depend on the sharpness of the capacity of observation. It was further confirmed that there is here a question of a curve showing the destructive power of light on the



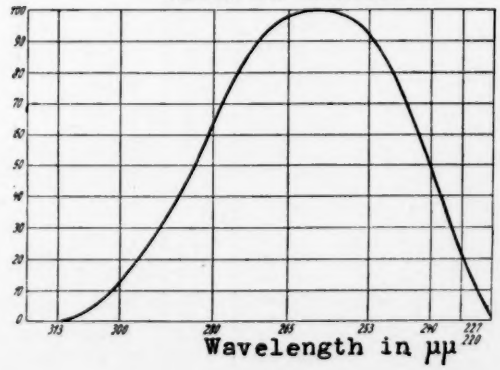
Albumen coagulating effect.



Death of bacteria.



Methaemoglobin.



Albumen reaction.

Fig. 9

FIG. 10
METHAEMOGLOBIN

Line	Proport. of Energy = E	I			II			III			Average
		Effect in Min. = T	Relat. Eff. 10 T - E	Relat. Eff. 100 at 265	Effect in Min. = T	Relat. Eff. 10 T - E	Relat. Eff. 100 at 265	Effect in Min. = T	Relat. Eff. 10 T - E	Relat. Eff. 100 at 265	
313 μμ	2.8 (4.3)	30	0.08	3	37	0.09	0.9				2
300 μμ	1.8 (3.0)	5	0.66	25	4	1.39	14	4	1.39	14	18
280 μμ	0.65 (1.0)	5	2.0	75	4	3.85	39	4	3.85	39	51
265 μμ	1.0 (1.5)	2.5	2.67	100	1	10.00	100	1	10.00	100	100
253 μμ	1.1				1		91	1	9.10	91	91
240 μμ	0.25 (0.55)	10	1.82	68	4		100	4	10.00	100	90
220 μμ 227 μμ	0.25				8	5.0	50	8	5.0	50	50

protein molecule by the experiments, which I later made as to the bactericidal power of light. I made such experiments with colon bacilli. I took a few drops of a fresh 24-hour bullion culture of colon bacilli spread over a plate of broth-agar which thereafter was given a covering of quartz. I irradiated the surface of the agar through the quartz covering with the lines, the back of the agar plate being divided into panels as with the preceding experiments. After cessation of the irradiation I placed the plate into the thermostat at 37 degrees and observed the result during the following day. Normally the bacteria should, without irradiation, have formed an even uniform growth over the agar surface. If the irradiation with the lines had had any effect this would show in no bacteria growing corresponding to the spots irradiated. With regard to some lines, only fractions of a second's irradiation close to the slit is necessary to kill the bacteria. In order to obtain an accurate measurement I have therefore had to use the lines at a rather great distance from the slit where the energy is less powerful.

In Figure 11 you see some of the results of these experiments. Also here the effect is strongest at 265 μμ and the curve has such a form. As I have just indicated this curve very handsomely corresponds to the albumen coagulation and the methemoglobin curves, respectively. It therefore is safe to assume that in the killing of the bacteria there is also a matter of albumen destruction, namely, of a destructive effect on the protoplasm of the bacteria cells. As an average curve between the three curves

DEATH OF THE BACTERIA

Line	Proport. of Energy = E	Dish Close to Slit			Dish Farther Away from Slit			Average
		Effect in Sec. = T	Relat. Eff. 10 T - E	Relat. Eff. 100 at 265	Effect in Sec. = T	Relat. Eff. 10 T - E	Relat. Eff. 100 at 265	
366 μμ	5.0	240 3360		0.001				0.001
313 μμ	2.8	60	0.06	0.2				0.2
300 μμ	1.8	8 8	0.7	2				2
280 μμ	0.65	2	7.7	20	4	3.8	76	76
265 μμ	1.0	2	5.0	13	2	5.0	100	100
253 μμ	1.1	2	4.5	12	2	4.5	90	90
240 μμ	0.25	4 4	10.0	26	32	1.3	26	26
220 μμ 227 μμ	0.25	8	5	13				13

Fig. 11

I have here as fourth on this picture drawn one which I have called the protein light-reaction curve. I think that, at all events for the present, there is reason to believe that this curve expresses how the light in proportion to the wave length acts destructively on the molecule of protein. The luminous rays which lie quite to the left of 313 have no material effect on the molecule, neither do the inner ultraviolet from about 400 $\mu\mu$ to 313 $\mu\mu$; only here a small effect commences, which thereafter rises somewhat evenly and reaches its maximum at about 260$\mu\mu$, thus far out in the ultraviolet, and from there again drop rather quickly. The maximum effect lies thus much farther out than the sunlight goes.

As you will remember the light hemolysis curve had quite another course.

You see it here together with the albumen light-reaction curve. As I said before, the light hemolysis is probably due to the destruction of the lipoid membrane of the blood corpuscles by the light. Perhaps we have in these two widely different curves. In the one the expression of the power of light to destruct a molecule of protein, in the other the power of light to destruct a molecule of lipoid.

The light reactions which could be spoken about with irradiation of animal organisms, must to a very great part depend in their primary forms of showing themselves on a destruction of these two kinds of molecules. A killing of bacteria is thus due to a destruction of protein molecules, a light erythema is probably primarily a destruction of certain cells in the skin, owing to a destruction of protein and lipoid molecules in the cells. However, it is not possible to conclude from this that with all light reactions on the animal organisms, it is exclusively the case of a combination of the two light effects on the protein and lipoid molecule. Thereto come of course also other essential cir-

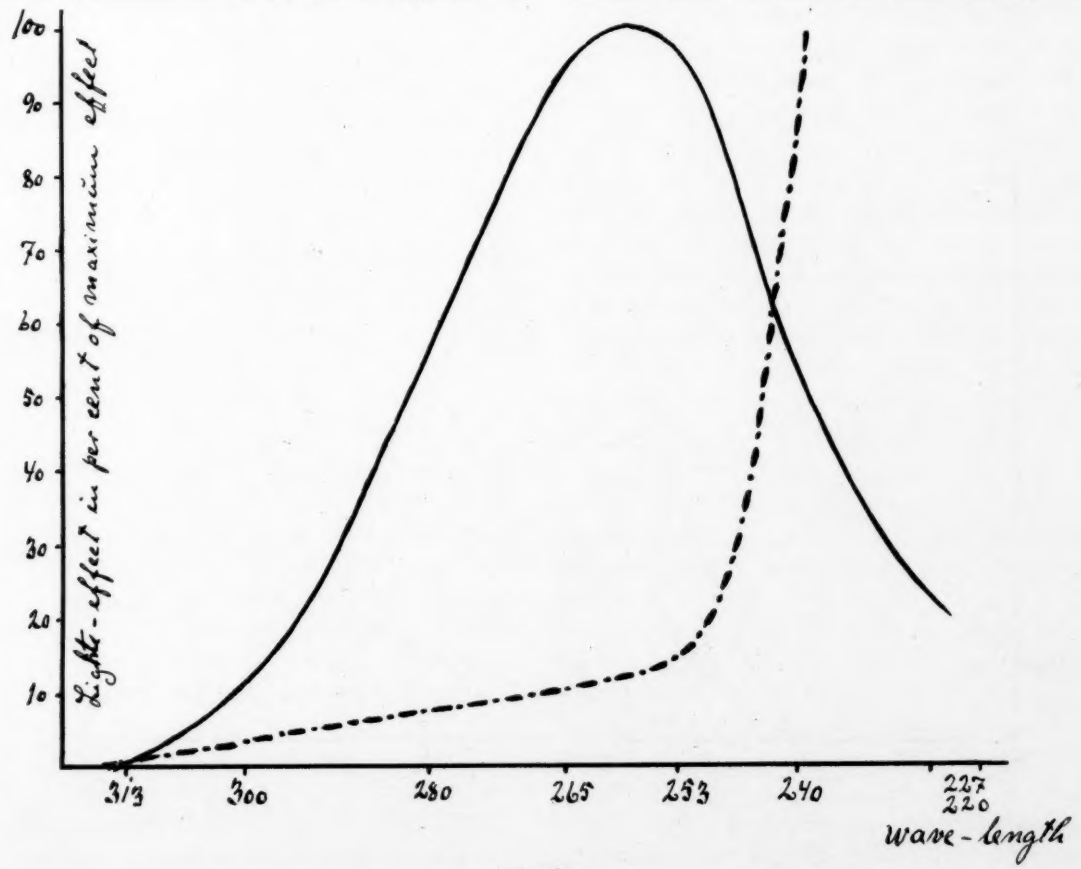


Fig. 12

———— Curve of Protein Light Reaction. —·—·— Curve of Hemolysis.

cumstances, which also may play an important part. There, for instance, among others, the power of penetration. By my experiments on the effect of the light on the killing of the paramecia, I believe I have a clear impression of the importance of this factor. The paramecia are comparatively large single cell animals which you just can see with the naked eye if they are swimming about in a drop of water. We have irradiated the paramecia in the hanging drop for various periods with different lines and examined how much was necessary to kill the animals, and have thereby found in the same manner as with the preceding experiments a reaction curve for the killing of paramecia (curve number Roman five).

You see it here (+) plotted in a system of coordinates together with the albumen light reaction curve, the lipoid reaction curve and Hausser & Vahle's erythema curve. As you see here the pure rise commences at the same place as for all the others, namely, at about 313$\mu\mu$, but it reaches a maximum already at 280$\mu\mu$ whereupon follows a drop and a fresh rise rather far out. It may be added that at the killing with lines about 280$\mu\mu$ there appears a considerable vacuolation of the animal's protoplasm for some time before death occurs, while at a killing far out in the spectrum there is hardly any vacuolising but the animals become only gradually stiff, quiet and die. I understand this in such a manner that with the first rise of the curve, death is due to a destruction of albumen in the protoplasm in the interior of the animal, at the latter it is due to a lipoid destruction on the surface of the animals corresponding to the rise of the lipoid destruction curve out there. If the first rise is not found at 260 $\mu\mu$, where the albumen destruction otherwise has its maximum, but already at 280 $\mu\mu$, this is simply due to the fact that the animals are so large that the rays at 260 $\mu\mu$ with the decreasing power of pene-

The latter part of the curve was found by my collaborator, Dr. Lassen.

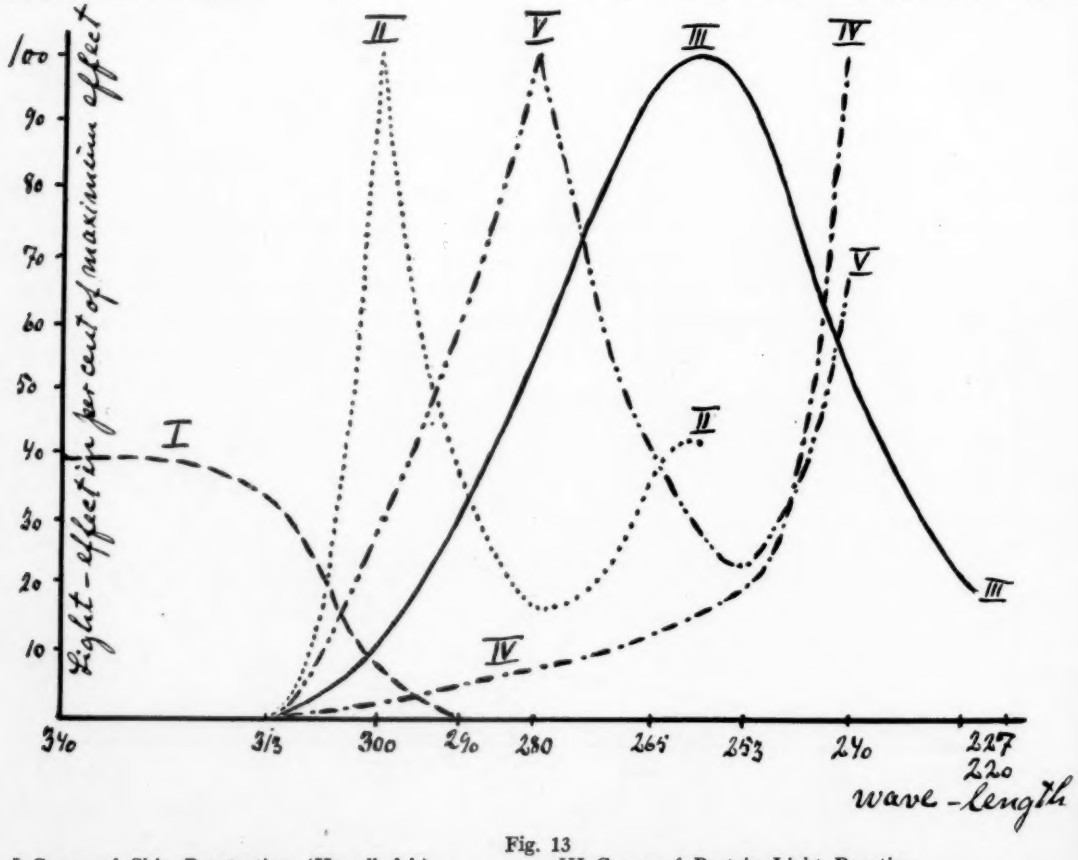


Fig. 13

I Curve of Skin Penetration (Hasselbalch).
II Curve of Erythema (Hausser and Vahle).
III Curve of Protein Light Reaction.
IV Curve of Hemolysis.
V Curve of Killing of Paramecia.

tration the farther we come out in the spectrum are no more able to penetrate so deep into the protoplasm, that they can assert themselves so strongly as the, by themselves weaker, but more penetrating rays at 280 μμ.

Quite similar arguments can apply to Hausser & Vahle's erythema curve. The powerful rays farther out in the spectrum cannot take effect here. They almost do not penetrate into the skin. Therefore we have the maximum for the erythema production already at about 300 μμ. Hasselbalch thought at his time to show, as you see here on this skin penetration curve, (diagram Number I) that rays outside of 290μμ practically did not penetrate the skin at all. According to Hausser and Vahle's previously mentioned later investigations, there seems, however, to exist a slight penetration at about 260 μμ corresponding to some elevation of the erythema curve at this place. It is a long recognized fact that the rays must be absorbed to be able to act. However, I cannot go further into the different absorption spectra of the various substances, so much the more as this would hardly afford essential contributions towards a better comprehension of the comparatively simple reactions, the process of which I have here described.

That the rays do not penetrate deep enough in the skin to produce an erythema, by no means excludes the fact that they can have a therapeutic effect. I shall refer to our experiments with rickets in my following paper.

After what I hitherto have said, one might ask, how I think the therapeutic action of the ultraviolet irradiation takes place. At almost all that until now I have said only the destructing effect of light on the molecules has been spoken about. I shall say to this, that I believe the therapeutic effect of the ultraviolet rays is just connected with such conversion or destruction; but how we do not yet know. However, as I said before, it is necessary to study as many reactions as possible, so that we gradually can feel the ground beneath our feet. That a destruction of cells, for example in the skin, can liberate substances, which in various ways can have a beneficial effect on the organisms, for example the mineral substance, perhaps a kind of chronic protein shock, is among others very possible.

I would, however, speak about a few series of experiments in which I sought to study more if possible the directly beneficial effect of the shortwave irradiation. Extremely important is the beneficial effect of the ultraviolet rays on rickets and, on the whole, in cases of defective mineral metabolism. But, as I have remarked several times, that had essentially been the subject of my last preceding paper, so that I shall not refer to it here. Another very important field in which light has a beneficial effect, namely in surgical tuberculosis, one has hitherto not been able to make the subject of exact scientific studies of the mode of action.

I have to the hundreds made experiments with light treatment of tuberculous infected guinea pigs and rabbits, but have never observed any reliable effect from them. Probably the artificial tuberculosis with these animals is quite different than the very chronically proceeding surgical tuberculosis of man. It would cause enormous difficulties to make experiments on man with this disease to ascertain exactly which range of rays come into question, and to carry them through satisfactorily, if it would be altogether possible. It would not be morally permissible to expose people exclusively to a certain kind of rays on the curative effect of which we are ignorant, who have been sick for a long time, while we know that a combination of rays will have a beneficial effect. We must therefore, for the present, be satisfied to say that with surgical tuberculosis we do not know anything certain, in how far the effect of the light bath shall be sought in the luminous part of the spectrum or in the ultraviolet part or in a combination of both. All three are possible, especially the latter. Where in the ultraviolet part the possible effect should be greatest, we of course have no opinion. The only thing which we can say in this respect, is that, as the sun light also has an excellent effect, it is proven that the rays beyond 290 μμ may be dispensed with, when

the inner ultraviolet rays occur in so ample quantities as in sunlight.

The two series of experiments with apparently direct beneficial effect of short wave irradiation, refer to an experiment on the effect of the rays with phototropisms and on the effect of the rays on the metabolism.

I shall only mention the first series quite shortly. The Dutch plant physiologist, Blaauw, has previously shown, that blue and violet rays act much more strongly phototropic than the longer wave yellow and green rays. The effect of the ultraviolet rays he did not examine. He examined the phototropism on quite young shoots of oats which had developed in the dark in the course of four to five days after the oat corn had been sown. I have also used similar oatshoots in my experiments which, when they were well 1 cm. large irradiated with various energy volumes at the different lines from our monochrometer. One hour and a half after the irradiation I observed the plants for a possible flexion in the direction of the irradiation. The volume of energy from the various lines required to just give phototropisms appears from the following table.

You see here, that the short wave blue line acts about 20,000 times as strongly as the long wave yellow one, and 10,000 times as strongly as the green one. To obtain phototropism in blue light only 3 per cent of the volume of energy is needed as is necessary for white light.

QUANTITY OF ENERGY REQUIRED FOR PRODUCING PHOTOTROPISM:

by—		
Yellow	577μμ—	588 L
Green	546μμ—	371 L
Blue	436μμ—	0.028 L
Violet	405 " —	0.06 L
Ultraviolet	366 " —	0.10 L
	313 " —	0.66 L
	302 " —	0.96 L
	280 " —	2.3 L
	265 " —	15.0 L
	253 " —	19.0 L
	240 " —	77.0 L

L = 0.86 × 10^5 gr. cal. per sq. cm. in one sec. = the quantity of white light required for producing phototropism.

FIG. 14

If we go further out into the spectrum from blue and if we go out into the ultraviolet we surely require still more energy, but a line like 302 μμ still acts just as strongly as white light, and even 240 μμ acts still 10 times as strongly as yellow light. The reason that the effect decreases out into the ultraviolet may very well be due to the fact that the power of penetration of these rays in plants decreases with the wave length. I do not intend to discuss these experiments more fully here, but shall only draw your attention to the fact that when once a light reaction has been fully recognized as beneficial to the living organisms and it has been ascertained that it is the short wave rays in the spectrum which are of particular influence on the appearance of this reaction, the possibility is thereby given by closer study of the character of the reaction to obtain some explanation on the fact how the ultraviolet rays can get beneficial or be of therapeutic value.

The other series of experiments refers to the effect of light on the oxygen metabolism of the pupae of meal worms. Here for almost a century experiments have been made on the influence of light on respiratory metabolism. The results the various authors have attained were very different. It must be assumed that the reason for this was because they did not make sure there were no muscle movements by the animals during the irradiation, partly, that if animals were employed which altogether did not perform any movement of their muscles, the irradiation was too weak. In reality no results whatever could be expected from the effect of a strong short wave irradiation on respiratory metabolism from the previously made experiments.

I have, as said before, made my experiments with pupae of meal worms. These do not perform any movements of the muscles neither respiratory and do not take any food, which likewise is of great importance. The oxygen metabolism is found by the animal being suspended for several hours in a Krogh micro-respiration apparatus, thus a glass bottle which is in communication with a finely graded manometer. The animal is suspended in a thermoneedle,

while its temperature under the wing roots and on the back could be controlled at any time. This is necessary, as the animal temperature will rise as a consequence of the irradiation, if no special precautions are taken, and such rise in temperature in itself would produce an increase of the oxygen metabolism, which it is of course necessary to eliminate when the object is to ascertain the possible specific chemical effect of light on the metabolism. By varying the temperature of the water bath, into which the bottle with the animals was immerged, according to the temperatures measured on the animal during irradiation, I was able to keep the temperature of the animal fully constant even during a very powerful irradiation. This was during these experiments not performed with a monochromator too weak for the purpose, but with a Kromayer lamp which with full flame a few centimeters from the animal, radiates on the same through a quartz window in the bottle. By means of different filtering arrangements I have been able to irradiate with light of different wave lengths.

Potassium bichromate filter, methylene blue filter, glass filter and absence of filter have given the light for the irradiation, as you see here by these spectra. The irradiation lasted from 30 minutes to one hour, and the metabolism was ascertained during the irradiation of the one or the other kind as well as without irradiation.

It would lead me too far away to here go into details of the finer technic of these experiments or to discuss the many different experiments which I have made. If there is any one who has any special interest in this, I have brought with me a number of reprints which I herewith place at your disposal. I shall limit myself to some remarks about the final results. An irradiation with yellow light proved always to be without influence on the oxygen metabolism. Even the lost intensive irradiation with yellow light had no influence. If I irradiated so, as I often did, first with blue light and then with yellow light, and then again with blue,or also blue in the middle and yellow first and last, and found the metabolism for each kind of irradiation, the blue light gives the same and always considerably greater oxygen metabolism than the yellow light. If I employed glass filters only, as you see on the spectra, I had even more short wave rays for the irradiation than with blue light and obtained a still higher rise of oxygen metabolism, and if I employed quite unfiltered light, whereby, as you see all ultraviolet rays were let through, the rise was still further increased. On the average the rise in the oxygen assimilation of the pupae of meal worms at the different kinds of irradiation were as follows:

At an irradiation with purely yellow light 0% rise of the assimilation, which is almost as if without irradiation.

At an irradiation with blue light an increase of the assimilation of about 10%.

At an irradiation with light filtered through glass, namely light which, besides the visible rays, also includes the most inner ultraviolet rays, an increase of 20% and

At an irradiation with non filtered light, where we also have all the outermost ultraviolet rays in the mercury light, an increase of the assimilation of about 40%.

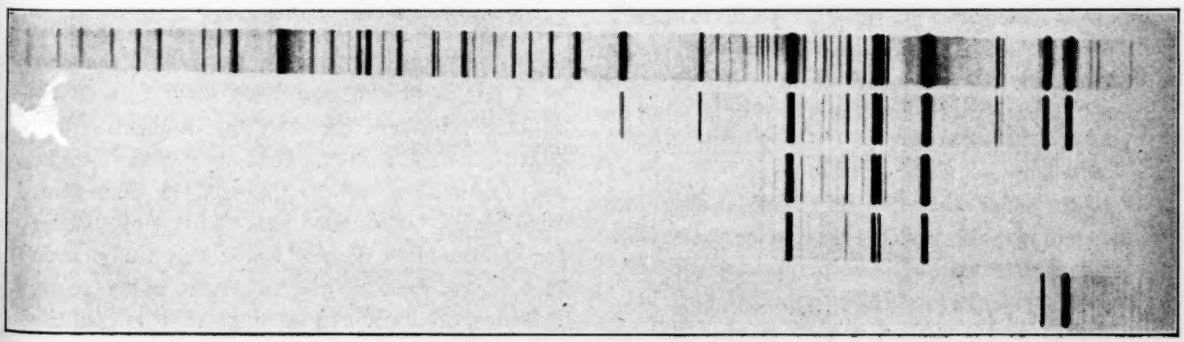


Fig. 15

Thus the more short wave light, the greater the increase of the oxygen assimilation.

There is, of course, a long spring from these experiments with these comparatively low standing animals to come to any final conclusions on the influence of light baths on the assimilation with man, but, at all events, we must say, that our knowledge of the biologically beneficial effects are brought a considerable step forward.

There is probably no question, that this effect on the oxygen assimilation of the pupae is in a certain relation to the beneficial influence which the same light may have on the defective mineral assimilation, as I have spoken about in my preceding paper.

To the experiments which I have spoken about today, it might perhaps be said that they have not directly contributed much to explain, how the ultraviolet rays in the light bath may be of therapeutic value. I admit this, but the introductory work is vast and difficult. It is necessary to work with light of accurately known composition, not alone as to quality but also as to quantity. Preferably monochromatic light should be used, that is each wave length should be examined by itself, while the intensity of the irradiation is know at the same time, thus measuring the radiant energy. Only when we know how the various qualities of rays act in a biological respect, may we hope to catch a glimpse of the therapeutic mode of action.

THE EVALUATION OF HELIOTHERAPY IN TUBERCULOSIS*

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I hardly need say that I greatly appreciate the honor of being asked to address you here this afternoon, though I am beginning to fear that I shall soon become known as the doctor with one idea! It happens that about four years ago I presented at a medical meeting some conclusions I had arrived at on the subject of heliotherapy in tuberculosis. Since then I have several times returned to the topic; and now I am about to begin again the familiar strain—much too familiar, some of you will think, perhaps, who have before heard me deliver a somewhat similar message. To those of you who are so unfortunate I can only say that my offense on this occasion is at least involuntary. I am once more talking about heliotherapy, but it is at the express request of your program committee.

In order that no misunderstanding may arise, it may be stated that the remarks about to be made regarding heliotherapy are concerned wholly with *natural* and not *artificial* heliotherapy, further that these remarks apply only to the direct application of the rays of the sun and not to their indirect use as in so-called air baths.

Heliotherapy, phototherapy, solar therapy, etc., are terms used interchangeably and with increasing frequency since 1913. Before then, although these terms had been in fairly common use abroad for about ten years, they practically did not exist in our own medical literature with one prominent exception noted elsewhere.[1] We may say then, that the epoch of heliotherapy for the United States of America began with the year 1913 and is now fifteen years old. It was undoubtedly brought about by the publication and distribution of Rollier's book *Die Heliotherapie der Tuberculose* which appeared in that year. It must not be assumed that the use of sun for the treatment of disease was a new thing, even then it had been in use for many, many years. It is only necessary to say here that despite the fact that modern heliotherapy was fathered by

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Finsen as early as 1893, its use in this country on any appreciable scale, did not start until twenty years later. Since then (1913) each year has seen more interest taken in it by American physicians, until now I fear it is the first thought with many doctors in their treatment of any kind of tuberculosis.

No one who has had any considerable experience with heliotherapy in tuberculosis would, I am sure, fail to agree that sun is a most valuable therapeutic agent when used in selected cases, carefully and cautiously, and with due regard to its possibility for harm. That it is being turned to much too often, especially in the pulmonary forms of the disease, and without due appreciation of its dangers, I am sure anyone will be convinced of who may even casually look into the matter. Because of its almost universal use, and very frequent abuse, I want to reemphasize the fact that the direct rays of the sun are a most powerful agent and that in their therapeutic use the greatest vigilance must be exercised. If the practice prevailing at present of resorting to sun so carelessly and miscellaneously continues, we shall soon be doing more harm with it than good. From observation of many patients, and from information obtained in discussion with doctors as well as laymen, I know that many sufferers from tuberculosis are being given sun treatment who should never under any circumstances receive it, and on the other hand, that many who who should receive it with benefit are being made worse by it. This condition of things must be corrected, but correction will not come until doctors in general get a different conception of the position which heliotherapy should occupy in tuberculosis. They must be made to realize that they must not prescribe sun as many of them are now doing, that cases must be chosen with care, and even then that the sun must be administered with great discretion and according to a most rigid technic. And always they must remember that this agent is just as potent to do harm as it is to do good.

Heliotherapy is in no sense a specific or cure for tuberculosis,—it is only a very valuable aid in some forms—a positive detriment in other forms. Rest, fresh air and good food are still the fundamentals in the treatment of all forms of tuberculosis, but because sun has come to occupy such a prominent place in the present day therapy of this disease, and because that place is so far from being well defined in the mind of the average doctor, I am glad to have this opportunity to address you, feeling that if I can present to you the results of a somewhat extensive personal experience in this field, especially if I can make you understand what has been learned concerning the powers and dangers of direct sunlight, the types of cases in which it should and in which it should not be used, together with a plan for distinguishing these types, and in addition say a word about the lack of understanding which still exists regarding the technic of administration, that it may help to clarify the whole matter and thus prevent much of its abuse and perhaps in a measure help to finally solve and master this intricate subject and give it its true evaluation in tuberculosis. I say help, for the final word cannot be said at present, it must be understood that the subject of heliotherapy in tuberculosis is complex and has some problems yet unsolved. The science or art of heliotherapy is comparatively new and for some time to come we must expect that increased experience will be followed by increased knowledge and its complete mastery will only come from the cumulation and correlation of the work of many workers, carried on over a period of years.

We do know certain definite things about it, however. We know that in some types of tuberculosis sun is most useful, that in others it is useless or far worse than useless; and we can distinguish roughly these types. We know further that it is seldom or never useful in any type of tuberculosis unless it is administered with patience and skill, and in accordance with a correct technic, and we can lay down with confidence the fundamental principles of a correct technic. What then is of practical value in what is at present certainly known will be presented, and certain conclusions drawn that will, it is hoped, enable us to place heliotherapy in its proper niche so far as tuberculosis is concerned. And now to do this I shall, rather than just

state to you my conclusions, tell you of some of my early experiences, and try to explain to you the processes of reasoning which at last led me to adopt the opinions which I now hold.

These opinions have been formed slowly, as the result of about fourteen years' constant use of sun in a practice embracing at all times from two hundred to three hundred tuberculous patients. Pulmonary tuberculosis is the greatly predominant form seen. The development which my ideas have undergone during this period may be very concretely suggested. Ten years ago I was giving sun to probably 50 or 60 per cent of all my patients, whether pulmonary or extrapulmonary cases; at the present time I am giving sun to not many more than 10 per cent of my patients, and of the cases represented by this 10 per cent only a small fraction are of the pulmonary form, and these are always of the proliferative type.

The use of heliotherapy in my own practice began in 1914. It was started prudently, with an occasional case, at first using it only in uncomplicated, so-called surgical tuberculosis, then later in the so-called surgical with pulmonary involvement, and, finally, having had good results in both of these types, in the pure pulmonary. At first in the pure pulmonary, the greatest caution was exercised. My new remedy was turned to in but few instances, and these few were chosen because they were showing no improvement. No attempt was made to select them according to any rule, for I knew no rule; but enough good results were obtained in these uncomplicated lung cases to encourage further experiment. I was soon prescribing sun to an increasing number of patients—to too many in fact, for one day it dawned upon me that under its use some cases were getting distinctly worse. What was the matter?

I thought first of my technic. Was that faulty? This was carefully reviewed, with the conclusion that the trouble was not here. From the beginning I had been deeply impressed by the principle so much insisted on by Rollier, that for each patient one must develop a separate technic according as he reacted to sun; moreover, the so-called surgical cases—including those with pulmonary involvement, where, as Rollier had pointed out, special attention was required—were nearly all getting well. The trouble, then, was not bad technic. Was it, possibly, after all, that heliotherapy had no place in lung tuberculosis, and that in thinking it had was Rollier quite wrong? Certainly an analysis of my results might seem to point in this direction. Furthermore, Rollier had admitted that he had no experience with pure pulmonary cases; his inference that since the sun was unquestionably valuable in surgical tuberculosis it was therefore valuable in pulmonary tuberculosis, was merely theoretical; it had no certain basis in fact.

Let me again state my problem. Under sun treatment practically all of my uncomplicated surgical cases got better; most of my surgical cases with lung lesions got better; and finally, and most perplexingly, *some* of my pure lung cases got better, and *some* of them got worse. What hypothesis could account for these partially contradictory facts?

The mystery certainly centered in lung tuberculosis. What was there in the nature of lung tuberculosis that might afford a clue? It was at this point that I began to attach significance to the well-known fact that this disease was of more than one type. Possibly, then, for one type of lung tuberculosis the sun was a good thing, and for another a bad thing. This hint, in the end, led to certain practical conclusions.

Before going further with this account of my experience, let me recall to mind the two large categories in one or the other of which we have come to classify most cases of pulmonary tuberculosis.

The disease commonly conforms to one of two types: (1) the exudative type, and (2) the proliferative type. It will be remembered that in the exudative type, in comparison with the proliferative type, there is usually a history of more acute and more severe onset, and there are more toxic symptoms, higher and more continued fever, more rapid pulse, more loss of weight, more coughing and expectoration. Often this

type is accompanied by night sweats. In the proliferative type, to put the matter conversely, the onset is less acute, slower, more gradual, and the patient has fewer toxic symptoms, less fever, slower pulse, less coughing and expectoration. In this type the patient frequently feels good, usually loses little in weight, or if he loses does so slowly, and has no night sweats. In fact, in the proliferative type the whole picture as contrasted with the exudative type is less severe and more chronic.

Physical examination in the exudative type very often shows only a comparatively small area of involvement, in spite of pronounced general symptoms, but on the other hand it reveals a tendency to more rapid extension and breaking down. Physical examination in the proliferative type usually shows a comparatively large area of involvement, with less conspicuous general symptoms and much less tendency to extension and breaking down; often in this type a large part of one or both lungs is involved, with many moist rales, but with little coughing or expectoration, and with very few or no general symptoms. In other words, in the exudative type there is often disproportion between the signs elicited by examination and the general symptoms, the latter being more severe than the physical signs would indicate. In the proliferative type there is the same disproportion, but it is turned round; there are more physical signs than the general symptoms would suggest. In their relation to each other the exudative type pursues a more florid, more rapid and acute course throughout; the proliferative type pursues a less angry, more indolent, more chronic course throughout.

Examined by means of the x-ray, the two types are distinguished as follows. In the exudative there is mottling, either fine or coarse without much peribronchial increase, and with a tendency for the mottling to coalesce, as the disease progresses, with cavity formation. In the proliferative type there are peribronchial strands or trunk formations, usually diffuse, often with fine beads along them; and there is not the tendency there is in the other type toward cavitation.

Such are the two broad divisions into which most cases of pulmonary tuberculosis fall, together with their salient characteristics. With these clearly in mind—to return to my story—I proceeded to review carefully the various cases which I had had under observation. It soon appeared that the lung lesions coincident with surgical tuberculosis could be classed, almost without exception, under the proliferative type. It also appeared that the pure pulmonary cases which improved under sun treatment belonged to the same type. On the other hand, the pure pulmonary cases which had become worse were almost always of the other—or exudative—type. In this, then, at last, was an explanation of the

CLASSIFICATION OF TUBERCULOSIS IN RELATION TO HELIOTHERAPY

Note: The scheme which follows is offered as a working classification only; it is made solely with reference to heliotherapy, and except in this connection it has no necessary meaning or value.

Extrapulmonary tuberculosis (so-called surgical: infections of external lymph glands, bones, joints, peritoneum, etc.)
- Without pulmonary lesion ..... Class 1
- With pulmonary lesion ..... Class 2

Pulmonary tuberculosis (infections of lungs and tracheobronchial glands)
- Productive:
  - Childhood type (tracheobronchial glands) ..... Class 3
  - Adult type (lungs) ..... Class 4
- Exudative ..... Class 5

Key

Class 1 to use sun treatment in all cases.

Class 2 to use sun treatment in all cases, but be careful to avoid reactions, and be especially careful in exposing the chest.

Class 3 to use sun treatment in all cases.

Class 4 to use sun treatment only in those cases which in spite of the best hygienic-dietetic treatment remain in a stationary condition or lose ground.

Class 5 never to use sun treatment.

whole difficulty: *Whether the use of sun was or was not indicated in any particular case depended upon the class to which the case belonged.*

Here appeared to be a general principle. The rest was a matter of detail. Ultimately it was found convenient—from the point of view of heliotherapy, and from that point of view alone—to divide all cases of tuberculosis into five classes. Though to a degree artificial, the division is both simple and practical and experience has proved that it definitely solves the problem of how to select cases for exposure to sun. It can perhaps be grasped most readily by means of a diagram. (See below).

It now remains, without any attempt to go into detail,[2] to say something in a general way about the technic of administration of sun in tuberculosis, for even after the case for heliotherapy has been properly selected this agent may be of no value or positively harmful unless the proper technic of administration is followed. In other words, the beneficial or successful use of heliotherapy in tuberculosis depends just as much upon the proper technic of administration as upon the proper selection of the case and consequently no true appraisement of heliotherapy in tuberculosis can be made unless technic is taken into consideration.

There is, unfortunately, a great deal of misunderstanding about this subject. Most physicians today know something of Rollier's experience with sun and of his results; in fact, mention heliotherapy to the average physician and he immediately thinks of him, and of no one else. Most physicians, too, have heard of his technic, or method, and here, it seems, is where the confusion arises. A great many confuse his technic with his zoning scheme. They seem to think that this zoning scheme—five minutes to the feet one or more times the first day; ten minutes to the feet and five minutes up to the knees the second day; and so on—comprises a technic. They appear to imagine that when they have mastered this simple procedure they have mastered heliotherapy. Indeed, one often hears this zoning scheme spoken of as if it were a definite, settled thing, as if it had been promulgated, once for all, as a precise program that could be used in exactly the same way on all patients—as, for instance, one would use some fixed laboratory method; but this is simply not true. He never intended his zoning scheme to be considered in the least as a technic for administering sun. Experience had taught him that if the sun was to be given to patients successfully it must be given in a very gradual manner; and that, by beginning with the extremities rather than with the trunk of the body or with the seat of the disease, a decongestive effect was produced, one was much less likely to get unexpected reactions, and it was easier to feel one's way. It was found out, moreover, that the average patient could stand five minutes as an initial exposure and could then gradually increase the exposure without bad effects. He therefore published his zoning scheme—but only as a measure to be used tentatively, and above all to be adopted to each individual according to his idiosyncratic reactions. If there is any one thing which he emphasized more than another, it is the necessity of finding out the amount of sun which each patient can stand. Another point on which he insisted is the need of great caution when approaching the chest; and still we see many patients exposing their chest exactly as they do the rest of their body, and this even in the presence of very active pulmonary tuberculosis. It is unfortunate but true that in giving sun, as in so many other things there is no short cut to a satisfactory technic, no hard and fast rule which one has only to follow in a mechanical way. Nor will the use of any instrument designed to measure the dose of sun administered enable the physician to escape this fundamental difficulty, regardless of how perfect the intrument might be. Because we possess instruments of precision, which will positively, for instance, measure the dose of Digitalis or Insulin accurately does not mean that the dose so measured can be given safely to *any* patient. Any well informed physician knows that a dose of either one of these medicines, that had been carefully and precisely measured, might be given to one patient with decided benefit and the same dose might greatly harm or even kill another patient. It is just so with heliotherapy.

The basic problem, of course, is to discover *what* the proper dose shall be, not to *measure out* the dose, no matter how precisely any instrument will enable this to be done. Such an instrument as I have referred to may conceivably become an important help in administrative technic, or from a purely scientific standpoint; it can never, in the nature of things, be anything more. Technic in heliotherapy properly so-called is made up of many and often elusive factors; and, depending as it does on individual differences which can not be known in advance, it must be developed little by little, as one goes along. A separate technic must be built up for for each patient, day by day, according as he reacts under exposure. One must never consider the zoning scheme as anything other than a way to start the patient off, which in many cases will have to be altered. One patient will be found unable to stand five minutes' initial exposure; another will stand this amount of initial exposure, but will not stand five minutes' daily increase; another will react still otherwise; how much may be given safely at any time can be known only by watching carefully the patient's actual response.

There is then—it cannot be repeated too strenuously—no such thing as reducing technic in sun treatment to a rule of thumb.

Finally, to present to you in as concise a manner as possible, and as a sort of summary, my own ideas of the evaluation of heliotherapy in tuberculosis, I submit the following brief paragraphs:

1. Heliotherapy is by no means indicated in all cases of tuberculosis. There are many tuberculous patients who should never use it. In general, direct sunlight is indicated in cases of extrapulmonary tuberculosis and contra-indicated in cases of pulmonary tuberculosis.

2. For no type of tuberculosis is heliotherapy a cure; but often, especially in the extrapulmonary cases, it is a very valuable—or even necessary—aid.

3. Since it is not in itself a cure, heliotherapy should never be used to the exclusion of the usual standard therapeutic measures.

4. Never should it be forgotten that the direct rays of the sun are extremely powerful, and that, carelessly administered, they can effect great harm.

5. Direct sunlight, in the same amount, affects patients differently—more differently, especially in the beginning of its use, than almost any other remedy with which I am familiar.

6. Obviously, therefore, it must be used, in every case, not according to any hard and fast rule, not according to any theoretically predetermined dosage, but according to the individual reaction.

7. Heliotherapy is of the greatest value, and may be practiced with the least chance of doing harm, in pure extrapulmonary tuberculosis, that is, in the so-called surgical tuberculosis without pulmonary lesion.

8. It is of great value in extrapulmonary tuberculosis with coincident pulmonary lesion; but in giving it here one must be far more careful than in the uncomplicated surgical type—particularly as regards exposing the thorax.

9. It is of great value in hilum gland tuberculosis, and in this type should invariably be used.

10. It is of some value in some cases of the proliferative type of pure pulmonary tuberculosis; but here it must be employed with the greatest caution, lest it transform a favorable, stationary, or healing lesion into a rapidly progressing and fatal one.

11. It is virtually never of value, and is often positively harmful, in the exudative type of pure pulmonary tuberculosis, as well as in all acute types; and in such cases, therefore, it ought never to be used.

12. Finally, in whatever type of tuberculosis heliotherapy is used, it should always leave the patient feeling the same, or better, both during and after his sunbath; if it does not do so, something is vitally wrong, and the patient should beware.

(110 South Scott St.)

DISCUSSION

DR. ELLIS B. FREILICH (Chicago): Most of us know that the value of heliotherapy in extrapulmonary tuberculosis has been practically established. The value of heliotherapy in pulmonary tuberculosis is an entirely different story. It has been and still is considered as doubtful in the case of pulmonary tuberculosis.

Dr. Watson, I believe, has summed up the situation in a statement that he has made, that success or failure of heliotherapy in pulmonary tuberculosis depends upon proper selection of cases, otherwise this therapeutic measure may do harm. He has given us a classification of results of his experience and this classification refers to the indications, and to the proper selection of cases. He has given as an indication for the use of heliotherapy in pulmonary tuberculosis the productive type of patient, the productive type of tuberculosis, and as contra-indication he has suggested the exudative type. Both these types are really pathological types and in order to understand these indications one of course must have a knowledge of pathology and the pathological processes going on in production and exudation in order to be able to clearly determine the kind of case he can use for heliotherapy.

I just want to dwell for a moment on this, getting back to the fundamentals as to the reaction of bodily health to bacillus. First of all, you know that even the tuberculosis bacillus is the result of an irritation. This irritation calls for the formation of tubercle. The body reacts four different ways to the presence of the tubercle in the lung: We have two constructive types, building up processes, that tend to shut off and shut down or shut in the tuberculous bacillus. Then we have two destructive forms. The first two constructive or building up or closing in processes are first of all simply the formation of fibrinous tissues. The further process, so far as time is concerned, is the introduction of calcium salts into the fibrinous tissue, and we have what is called calcification. There we have the formation of fibrinous tissue and the calcification of that tissue, two methods which the body reacts to in aiding the individual to relieve him of this irritation.

In reverse we have the destructive processes. We have what is called, first of all, ulceration, and this, of course, is a breaking down of the tissue, forming what is known as ulcers, and an extension of this ulcer to cavity formation.

On the one side we have a fibrinous tissue formation and later a calcification; on the other side ulceration and eventually, if this goes on, cavity formation.

The first two practically occur in the productive type of cases; the second two occur in the exudative type. I prefer to use the terms which perhaps may be more simple, the fibroid and ulcerative, commonly used in clinical work. Very largely this is determined by certain groups of people, national groups and national types, racial types, etc., and we know that certain types tend to develop fibrosis before they begin to develop the other group. Knowledge of this is essential in picking out your patients for the treatments.

The fibroid type of patient naturally is one in whom the resistance is greater and there is greater possibility of shutting off or controlling the tuberculosis infection. The exudative type of patient is the one we call active; he is the patient who is sickest and shows the symptoms of toxemia, etc. With the sick patient if you use any method as an adjunct the treatment tends to increase the activation, and of course you are continuing that irritation and destruction until your patient is more sick than he was before. If he is a fibroid patient then of course there is an indication for an adjunctive treatment. This is a combination of the two.

You will fiind the exudative type of patient in the home, and there are many cases of this type where the fibrosis goes on in one place and ulceration in the other. These have no signs or symptoms of toxemia; they have the signs of fibrosis or ulceration, but symptomatically they are free from toxemia. They are up and around and go about their business. That is what we classify, so far as the National Tuberculosis Association is concerned, as the quiescent type of patient. In that patient the lesions persist, and when we examine him day after day and week after week and month after month we find very much the same sort of findings: We find moisture and signs of fibrosis. That type of patient is the quiescent; he is neither getting better nor getting worse, and a patient of that type to me offers a very suitable indication for some sort of stimulation which will help in definitely controlling the ulcerative part and developing the fibroid lesions.

The other type of patient, most of them, may be far advanced, plainly with very extensive lesions, but clinically they are apparently getting well. Many of those patients know they can't get well. The type that is up and about doesn't know he has tuberculosis. The ulcerative type with toxemia is more or less of a poor risk as far as giving him some stimulation, a whip to his waning powers; his metabolic functions are at a low ebb and usually may become worse.

I just want to repeat before closing, Dr. Watson's thought, that your failure or success practically depends upon proper selection of cases and a knowledge that your treatments may do harm. If you realize that your treatments may do harm then you will go about it carefully in selecting your patients rather than just treat the patient upon the basis of the presence or absence of tuberculosis bacillus in the sputum. For example, many doctors depend upon that one basis in making their diagnosis for treatment and that is no indication as to the type of disease or whether the patient is the productive or the exudative type. The roentgenological findings will not tell absolutely whether the patient is one or the other type of patient. You must know your patient, get his history, his symptoms, know his chest, know his physical signs, get the x-ray

findings; and if you can decide definitely, then you can try heliotherapy with the hope that you are going to improve his condition and not harm him. At the slightest change when using heliotherapy, when you notice signs of activity in the patient, when he is beginning to develop a nice sweat and a rise of temperature, then that is the time to shut it off and give it up.

DR. CARL SONNE (Copenhagen, Denmark): I learned much from this paper and should like to offer a few remarks with reference to treatment of tuberculosis with artificial light. The effect of treatment with sunlight is quite different than that of artificial radiation. There are more of the luminous rays in sunlight, so it is necessary to be more careful. The amount of luminous rays in the sunlight will very easily produce a rise of temperature of the body; for that reason we must be extremely careful when we begin to give sunlight treatment. We must begin with a few minutes' exposure, and when the rays start to penetrate the temperature will rise.

If we will try to treat the patient with artificial light I should think that this fractional method is not quite so necessary. In patients with pulmonary tuberculosis the reaction of the body temperature to the artificial radiation is essential to watch. We must take the temperature both before and after the light bath, and there should not be much rise in temperature, at least only of one degree or so, and if there is a rise in temperature before the light bath you must never give the light bath.

We in Denmark have not been treating so many of the patients with pulmonary tuberculosis with the light bath, but since we have treated the other tuberculous patients, we also have observed several patients with pulmonary tuberculosis, in some cases with very severe pulmonary tuberculosis.

Dr. Stromberg in Copenhagen who has treated more than 200 patients with pulmonary tuberculosis with artificial carbon arc light, and in some cases also with the mercury vapor lamp bath, saw in several cases a very good effect. Several of these cases, as I said, were very severe ones. Of sixty cases only sixteen were in the first stage; seventeen in the second, and twenty-five in the third, while two had pleurisy. Of the sixteen in the first stage the lung conditions improved considerably; of the 17 there was improvement in nine, in three the disease remained stationary and in four there was propagation. Of the twenty-five in the third stage, the pulmonary condition improved in five; in thirteen it was stagnant, and in seven there was propagation.

He can't understand the fear that is felt concerning the pulmonary cases, especially when it is remembered that these cases comprise almost entirely poor outpatients. They are almost entirely poor outpatients, none of them enjoying any of the comforts of state sanitoria, and in many cases when undergoing treatment, have been obliged to carry on with the bare necessities of life. He can't understand it but imagines that these results can be greatly bettered by sanitoria where the patients could have more comfort and conveniences at their disposal.

I think he is right in this matter, and I am glad to have heard this paper by Dr. Watson, who also seems to have had very good results.

DR. SAMUEL H. WATSON (Closing): I have very little further to say except to thank Dr. Freilich and Dr. Sonne for their discussions and to add that I am inclined to agree with Dr. Sonne that one does not have to be quite so careful in using artificial light as in natural heliotherapy.

However, one must be careful, even with artificial light, especially in pulmorary cases.

ARTERIAL HYPERTENSION AND PHYSICAL THERAPY*

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Arterial hypertension is still considered one of the unsolved problems of present day medicine.

While it is true in many instances that the problem of blood pressure plays but a minor role, it is also true that in many others it is of such importance as to constitute the chief concern of both physician and patient. Such cases give rise to alarming symptoms and no inconsiderable number of deaths. Hypertension is indeed as serious a public problem as is tuberculosis or cancer. Tuberculosis is more or less on the decline, because great efforts have been inaugurated in all parts of the country for its study, prevention and eradication. Cancer is still on the increase; its solution is still as elusive today as it was decades ago, and this in spite of the tireless research the world over.

High blood pressure does not generally impress one as a serious menace; its complications

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and sequelae, however, cause more casualties than cancer and tuberculosis combined. It is well known by the profession that the mortality from cardiac complications, renal affections, apoplectic seizures and similar accompaniments of high arterial tension is tremendous, and that its morbidity is great,—greater than that of any other disease recorded. Arterial hypertension is therefore a serious problem, and its consideration by the medical profession is timely and warranted.

Etiology

It would be impractical in the short period allotted to me to attempt more than a brief survey of the etiological factors ascribed to high arterial tension. There are many theories advanced to explain the cause of this condition. This in itself is proof that the essential cause of hypertension is still unknown.

Many investigators assume for hypertension an endocrine basis, because various secretory hormones and organ extracts possess *pressor* qualities. Extracts from thymus, brain, and stomach have been studied by Popielski (1); from thyroid, spleen and brain by Oliver and Schafer (2); thyroid residue by Fawcett (3); liver extracts by Roger (4), Reed (5), and others; these organs have been accredited as affecting blood pressure.

A few years ago the author (6) described a type of hypertension, "hypertensio-dyspituitaria," which may occur in multiparous, middle aged, pituitotrope women. This is probably due to an increase of the pressure-raising pituitary hormone, secreted by a hyperfunctioning, greatly enlarged hypophysis, as disclosed radiographically by a large sella turcica. It is a known fact that the hypophysis enlarges with every pregnancy; and while it partly recedes after each parturition, it, nevertheless, remains somewhat enlarged and persists hypertrophied. Since the pituitary hormone through its influence upon cardiac and vascular musculature is a normal factor in the maintenance of arterial tension, excess of its production by a hypertrophied hypophysis induces increased arterial tension. Many of the so-called menopausal, essential pressure cases are undoubtedly of this type. Since our first description of it in 1921 we have had frequent occasions to study and verify our original observations.

That heredity plays an important role in individuals with high blood pressure has been pointed out long before the invention of the sphygmomanometer. This condition is recognized as a familial trait inherited by many members of successive generations. It was called *typus apoplecticus* and was known to be associated with cerebral hemorrhages, cardiac failures, Brights disease and similar grave diseases in various members of a family. In recent years Bauer (7), Barker (8), Draper (9), Hurst (10), Gutman (11), O'Hare, Walker and Vichers (12) and others have described more explicitly the relationship of constitution, inheritance and high blood pressure and have shown its connection with the endocrine system.

Living conditions, great mental stress, aggravation, focal infection, overeating and similar phenomena have also been identified with increases in blood pressure, influenced, perhaps, through some irritation of the vasomotor system.

Various proteins and their derivatives have been studied for their effects upon blood pressure. It was found that many amins and diamins, products of incomplete protein digestion, even in minute dosage, powerfully influence blood pressure. Nuzum, and co-workers (13) experimented with proteins from soy bean, liver and grain, and induced with these an increase of blood pressure in animals. Major (14) proved the potency of extractives such as the guanidine bases, with which he was enabled to double and treble blood pressure for several hours in dogs. Fishberg (15) and others found in hypertension blood a marked increase of uric acid without increase of any other nonprotein nitrogen substances. Invernizzi (16) from a study of 369 cases concludes that a general angiospasm of toxic origin is the factor in essential cases. Cash (17) claims degenerated renal tissue to be productive of high blood pressure in nephritics. Danzer, Brady and Miles (18) speak of the

presence of a *pressor* substance in the blood of the hyperpietic organism, which, if injected, induces a similar state in others. That lead, arsenic, alcohol and syphilis are productive of high tension is a fact known to all clinicians; also, that various metabolic disturbances such as gout, diabetes, obesity, polycythemia vera, increased blood volume and viscosity, increased chloride retention, etc. are commonly accompanied by high blood pressure.

Colon and Hypertension

There is one other very important factor which is so often encountered in individuals with high blood pressure that it requires special consideration, namely constipation and its resultant disturbances. It is surprising that the researches of Alvarez and his associates (19) led them to eliminate constipation as a factor. From a study of 410 males and 585 females, most of whom were habitually constipated, and others, he concludes that "in men constipation has absolutely no effect on blood pressure; in women there is a pretty definite connection between constipation and a slightly lower mean blood pressure." "It is possible," he further states, "that diarrhea is also associated with a lower pressure but our data are too few for trustworthy conclusions." He furthermore states "in studying these data there are three possible interpretations—constipation may lower the pressure; lower pressure may cause the constipation; and higher pressure may be slightly laxative" deriding at the same time "those who live by washing colons and those who have for sale laxative drugs, foods and patented syringes."

While we have the profoundest respect for Alvarez and his scientific researches we cannot subscribe to these conclusions. We admit that lack of regular intestinal evacuations need produce no symptoms; all know of cases where evacuations occur once in several days, and yet these individuals are apparently in good health. The products resulting from such sluggish movements may be injurious to others. These products and their poisonous character depend upon many factors: the kind of food ingested, the body ferments, the type of intestinal bacteria present, the individual's constitutional habitus, his natural resistance, general health, environment, etc. If conditions favor the production of toxic substances pharmacologically active as pressor or depressor, the blood pressure or other functions of the organism will be affected; and if these factors are constant, so will be the effects. It is the absorption of such intestinal toxins even where evacuations occur daily that causes pathologic phenomena, particularly in abnormal colons which the radiologist sees almost daily in his routine work.

Of late, the writer (20) again called attention to the colon as a source of autointoxication. Indeed, the colon is now regarded as the greatest focus of infection, more so than tonsils, teeth or other infection carrying organs. The colon is an excellent place for toxin production; there are always bacteria present, pathologic and facultative pathologic; the temperature, moisture, nutrient substances, food residues, incompletely split proteins and similar ingredients constitute good media for bacterial growth and activity. The abnormal colon, the one that is dilated, atonic, displaced, kinked, adherent, diverticulated or ulcerated is even a more favorable site for bacterial development and toxin production. If, in addition, there is an inefficient ileocecal valve permitting the reflux of bacteria-laden colon contents into the semi-sterile, all absorbing ileum, the opportunities for autointoxication are almost perfect.

The nitrogen type of putrefactive bacteria are very active and their products very potent, more so than the products of microorganisms attacking non-nitrogenous products. Amino compounds of putrefactive origin are constantly formed by the bacillus *aminophilus intestinalis*, the bacillus *coil communis* and others. In the constipated individual, particularly in one imbibing considerable fluids and thus adding moisture to the solid bowel contents, even more so. Many monoamino compounds and even the bacteria themselves, or their Berkerfield filtrates, are extremely powerful vasoconstrictors as shown by the beautiful researches of Koessler and his co-workers (21). Hawk (22) states that "the monoamino derivatives when injected directly

into the blood stream have a powerful action on unstriped muscle, giving an immediate and very pronounced effect on arterial tension; even a few milligrams of the amine cause an alarming increase."

Fortunately under normal conditions these poisonous amins and bacterial toxins are produced in infinitesimal quantities, and upon reaching the portal circulation are readily destroyed in the liver. But where there is an overproduction of toxins as in abnormal cases, or where liver function is inadequate the absorption of these poisonous substances into the blood stream causes arterial hypertension, transient if occasional, and permanent if absorption is steady. The same is true of metabolic and endogenous substances, such as excessive suprarenal secretion or pituitary hormone or other incretions, or of uric acid, guanidine, etc. All this is important to bear in mind if a case of high blood pressure is to be treated rationally. The curtailment and elimination of these obnoxious substances is essential to success.

Treatment

Excepting those of the consitutional and familial types, we treat our hypertension cases on the basis of either toxic invasion, bacterial or endogenous, or metabolic dysfunction. The treatment is mostly eliminative and corrective.

Many individuals, particularly those accidently discovering their higher blood pressure, perhaps while applying for life insurance, or while visiting a physician for some other ailment, may require no other treatment than reassurance or psychotherapy. The transitory cases which occur after physical exertion, ingestion of food, mental excitement, during menstrual or menopausal periods, or during pseudo-anginous attacks are not true hypertension cases, and may or may not need some attention. The essential cases, who exhibit no apparent, determinable cause, despite vigorous search, are possibly due to some irritant of the vasomotor center or basal vessels, and demand other procedure. Those suffering such minor symptoms as headaches upon walking, early fatigue, languor, discouragement, slight dyspnea, vertigo, occasional palpitation, etc. may be alleviated by symptomatic treatment and judicious use of the numerous drugs applicable in such conditions. But those who present serious pathology with evidences of cardiac insufficiency, Brights disease, arteriosclerosis, or such grave symptoms as hemorrhages from the nose, mouth, bowel, retina, or with aphasias, edemas, etc. deserve serious attention and more specific therapy.

Before we may rationally treat a patient with higher blood pressure, decision must first be made whether his pressure is really abnormal; hence we must have definite standards to guide us. To establish such standards has been the endeavor of many clinicians, but only general averages have been agreed upon for men and women of definite ages and constitutions.

We use as averages at our Institute* in males the formula of 100 plus age of patient to thirty, and 100 plus half the age over thirty; in females from 7 to 10 mm. less, allowing in both for the constitutional habitus of the individual. Our figures closely coincide with those of Lintz (26) who states, "the normal for adult males below thirty is 120 to 130 systolic and 80 diastolic; between thirty and fifty 130 to 140 systolic, 85-95 diastolic; between fifty and sixty 140 to 160 systolic, 85-95 diastolic. The average pulse pressure is 45 which increases one mm. every two years from forty to sixty, 2 mm. each year after sixty. A pressure of 150 in men below fifty, or of 160 beyond that age requires investigation."

To determine the presence of toxic factors and metabolic disturbances, each case must be thoroughly investigated. To disclose bacterial invasion and toxicity careful search for foci of infection is to be made, which comprises, after an exhaustive clinical examination, radiography of the teeth, a study of nasopharynx and sinuses, culture of tonsils, radiography of gastro-intestinal tract including careful study of colon, culture of feces and contents of gall bladder after drainage. Where metabolic disturbances are suspected, additional studies must be made such as blood chemical tests, basal metabolism, kidney,

*Brooklyn Diagnostic Institute, Brooklyn, N. Y. 1925.

liver and other function tests, and various other laboratory investigations as indicated.

Following such a course we found use for every type of therapy. The results were in the main satisfactory. We shall not at this time recite our experiences with individual methods. We wish, however, to emphasize, that rest is invaluable in every case of hypertension, especially those showing first evidences of cardiac weakness with occasional pulmonary congestion, slight cough or mild cyanotic hue; also, that graded exercises, soothing tepid baths, regulation of quantity of food, decrease of mental stress and physical strain, diminished intake of salt help in obtaining satisfactory results in a number of cases.

Physical Therapy

Our success with physical therapy has given us the greatest encouragement. The modalities used were principally for their detoxicating effect. We shall mention only those actually used and briefly state the reasons therefor.

Electric Cabinet Baths. These were used to induce sweating and to promote elimination, particularly of uric acid. It was also used in the obese to promote reduction by dehydration which is desirable in all hypertension cases. Our cabinets are supplied with twenty-six and thirty-six Mazda bulbs which deliver more light and less heat than carbon lamps and induce gradual and copious sweating with a minimum of weakness and chances for prostration. Treatments, lasting ten to twenty minutes, depending upon reaction, twice weekly.

Autocondensation. This was utilized because it increases leukocytosis and oxidation, attenuates virulent bacteria, increases electrical responsiveness, activates lipoid tissues, stabilizes the sympathetic system with its effects upon vasomotor, secretory and peristaltic activities. Allbutt (28) long ago wrote that "autocondensation is, I believe, the most valuable immediate aid we possess for hyperpiesis. It is true that it does not, so far as we know, counteract the direct cause or causes of the malady, but until we know the primary cause we may be thankful to counteract the secondary."

The effects of autocondensation are rather lasting; reduction of pressure was observed after individual treatments from 5 to 15 mm. If correct technic is used which includes attention to the type of individual, voltage, amperage, frequency and time of application, the results are gratifying. Improper technic and poorly selected cases as Grover (29) points out are the causes of disappointment by those denying the efficacy of autocondensation. We use a regular Wappler outfit, 220 volt., A. C., from 600 to 800 milliamps current for 20-30 minutes, 2-3 times weekly.

Bergonie Treatment. Bergonie treatment for 15-30 minutes with current as much as patient can bear and applied to places with most adipose tissue is our other means of reducing weight in the obese with hypertension, especially in women to whom ordinary exercises are distasteful.

Vibratory Treatment. Vibratory massage applied at the second and third intervertebral spaces, in the right and left dorsal regions, using short stroke and slow vibration for 5 to 7 minutes, as recommended by Snow (30), we found very gratifying to the patient, though transitory in its effects. It has a physiologic basis, is valuable in appropriate cases and deserves a trial in many instances.

Colon Therapy. To this therapy we ascribe most of our good results in the treatment of hypertension cases. It was used principally for eliminative and detoxicating purposes. Although Alvarez makes light of "colon washes," those utilizing this method of cleaning the intestines and removing disease producing bacteria, potent toxins, and decomposing foods will admit its efficacy. In addition, its improvement of muscular tone and the help it affords in restoring a sluggish bowel into an active one by stimulating peristalsis, makes it a valuable substitute for the radical Lane operation in overcoming intestinal intoxication. In postoperative cases, colonic irrigations are frequent life savers and have saved the life of the patient and the reputation of the

surgeon upon more than one occasion. Every clinician also will attest to the great aid this method affords him in ridding the sick from numerous symptoms, local and reflex, resulting from colonic stasis.

In hypertension, colon irrigations scientifically administered, and not given merely like an enema, give great satisfaction. For cleansing, large quantities of alkaline or saline solutions must be used, followed by the injection of antiseptics, astringents, (aqueous fluid extract of Krameria, mercurochrome, Rivanol, Argyrol) or the implantation of acidophilus products. After colonic lavage our cases were given the necessary electrotherapy:—diathermia to soften intra-abdominal adhesions and induce favorable congestive reactions, galvanic, sinusoidal and other currents for atonicity, dilatation and lack of peristalsis; spastic colons were treated with relaxing currents; displaced, ptosed and kinked coils were replaced and straightened by manual massage. It was very pleasing to watch the lowering of blood pressures with the improvements of colons as shown by radiographic re-examinations, stool cultures and disappearance of symptoms.

CONCLUSIONS*

1. We must treat our hypertension cases individually, and meet the conditions presented in each case.

2. Every form of therapy should be used which experience teaches is beneficial; no one system is applicable to all.

3. Accompanying complications must be attended in a manner best known for these diseases.

4. Toxic, endocrine, constitutional disturbances, wherever possible, must be removed, or at least attenuated.

5. Suppurative foci must be eradicated.

6. Colonic irrigations are to be administered in normal colons at least once or twice a week, and in the abnormal perhaps more frequently. Large quantities of alkalines and salines, followed by mild antiseptics or implantation of acidophilus bacilli must be instituted.

7. All colon abnormalities leading to intestinal stasis, bacterial activity and production of toxins, must receive appropriate treatment as indicated in each case.

8. Electric cabinet baths for the elimination of uric acid and other poisonous substances; massage and Bergonie treatment to improve the circulation and reduce excessive weight; special dietary measures must be observed:—restricting quantity in obesity, carbohydates in diabetics, salts and purine rich foods in nephritics. Rest, personal hygiene, restriction of physical and mental strain should be prescribed in all cases as part of the general treatment.

*Due to lack of space the case reports have been omitted herein, but will be included in the reprints.

DISCUSSION

DR. PENNINGTON (Indianapolis): From our experience on giving colonic irrigations from the x-ray standpoint, as the doctor stated, it is not necessary to insert a rectal tip and we usually introduce our enemas very nicely. In fact, it is a very rare thing that a rectal tip and two to two and one-half feet of pressure won't fill the colon.

In regard to his treatments, I don't know much about it. In fact I do not know anything about it, but I have inserted tubes by getting a regular, heavy colon tube, and by manipulation I have been able to insert it around to the cecum. Of course, that is impracticable from my standpoint, because my purpose is to show what we can prove from the x-ray. I have never seen it indicated. I have merely tried to see if it could be done, and in some instances where you get a long and rectangular sigmoid (and I have seen sigmoids that would go up under the diaphragm), in a case like that, it would be almost an impossibility to insert a tube. But where a colon is not fixed in that position I have found it very easy to slip a tube around there.

DR. VOILS: I shall take but a few moments of your time. I wish to express my appreciation of this splendid presentation, and I wish to ask the essayist one or two questions. I should like to ask if those films were taken when the patients were lying down or in a perpendicular position.

In regard to the question of colon flushing, he may have created a wrong impression or may be misunderstood. I understood that when you have a case like he mentions it should call for a colon massage. I gave it for years in carefully selected cases; especially the atonic type of cases are likely to be greatly benefitted.

For instance, I call to mind a case who had such a marked degree of colonic stasis that the patient had had practically no normal movements in seven years. We were satisfied in our mind that it was the atonic

type. That was a good many years ago. The patient slowly and gradually improved and under about three months of office treatments the colonic stasis was cured; the patient has had no relapse in twenty-two or three years and never requires a cathartic. The symptoms of colitis disappeared as soon as the bowel was fixed up.

DR. EHRET (Cleveland): We have been told that the Morris Wave plate on the back would give us about all the flushing of the bowel that was necessary.

I should like to ask if the speaker has had any experience along the line of using the Morris Wave.

DR. MORIAN (Denver): We have treated quite a number of cases of high blood pressure. On some we have had very good results; on others we have not.

One case in particular we treated a man fifty-two years of age, and we could find no evidence of pathology in the kidneys or in the heart, but he had a very high blood pressure. We resorted to everything including dieting, colon washing, sinusoidal current, Morris Wave, and other physical therapy measures without results. The only evidence, if anything, was in the heart. There was a slight effect there. I said before that there are some cases that respond very beautifully to diathermy, sometimes by giving autocondensation directly through the liver.

I should like to ask the essayist in view of the fact that in this particular case I mention there was no evidence of kidney or heart trouble, how he would treat a case of high diastolic as well as high systolic pressure.

DR. JACOB GUTMAN (Brooklyn): I shall make my discussion very short.

Dr. Voils asked me whether those x-ray slides that I showed here on the screen were taken in an upright position of the patient or if lying down. They were taken lying down, in the prone position. The object of taking x-ray plates was only for the purpose of finding out the condition of the colon and not of showing its physiology. If you want to study the colon function you must keep the patient in a position where you can watch the flow of the meal through the organ.

In those cases of high systolic and high diastolic pressure, we find that, in addition to the physical therapy, injections intravenously of iodides would give us some very excellent results.

As to the matter of salts, that is a debatable question. Some claim that it is an advantage to decrease salts; others say that this has no value at all.

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THE TREATMENT OF MALIGNANT CONDITIONS WITH RADIUM EMANATION WITH SPECIAL REFERENCE TO THE SO-CALLED HOPELESS CASES*

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In a community hospital where general medical and surgical care is offered patients, there are many who come for relief of lesions for which the usual routine therapy is not applicable. This is especially true in the care of cases of malignancy. In very many instances patients undergoing treatment for clinical symptoms are found to present malignant lesions hitherto unsuspected. The lesions presented may, in the early stage, be wholely operable, or, in the more or less advanced stages, where little in the way of surgical manipulation can be done. In communities where there is a special hospital with an adequate supply of radium, and x-ray apparatus, these cases can be turned over to such an organization for treatment. In but few instances is this procedure possible, and in most cases it is inadvisable. If any advancement is to be made in the treatment of malignancy, the medical man first seeing the case should be taught to properly handle the condition when first identified.

There is no one element offering so much aid to those who are fighting against malignancy as that offered by radiation. Radium is among the most useful radiant therapeutic agencies used in the treatment of cancer. However, to be used advantageously it must be on hand whenever wanted in a readily applicable form and in sufficient quantities to be of real value in the treatment. This unfortunately is not always practicable as radium is a very costly element and requires special handling and care. However, in its process of disintegration, it gives off a gas radon or radium emanation, which to all intents and purposes acts biologically as radium itself does, but which is much more economical and more convenient to use, more readily applied, and does not require protection against loss. The surgeon using emanation is not required to invest in costly material, as emanation can be bought when and as needed in the specific form, quantity and shape of applicator as required for the specific case on hand. One of the most useful forms of emanation applicators is the small capillary tubule called radon seed. It was in 1927 that Dr. Janeway, at the suggestion of Dr. Duane, first used such applicators in the interstitial treatment of tumors. Those first seeds were made of glass which did not filter out the caustic rays, and necrosis and destruction of tissue were frequent sequelae following their use. For many years the Regaud School in Paris has advocated radiation treatment with the radioactive element encased in metal filters and has shown remarkable results following such usage. In 1925 Dr. Failla made the "seeds" of gold capillaries, the metallic gold filtering to a certain extent most of the caustic rays emitted by radon tubules. Quick and Cutler have shown some excellent results with these new "seeds," and they are regularly employed now in the treatment of malignancy. Gold seeds are readily sterilizable, easily handled, and their use requires no special technic not easily acquired by the intelligent physician. In Bellevue Hospital, where nearly two thousand cases yearly are treated by radiation, where the type and class of the patients are not always of the highest standard, where the patients usually present lesions markedly advanced, and where a large portion of the radium treatment has to be given in ambulatory cases, radon implants have been most serviceable.

Radon gold implants or seeds may be used alone or in conjunction with radiation by element or x-rays. We have found it effective to use gold seeds in such cases where the lesion was not readily accessible or where radium element application would require difficulties in subsequent removal of the applicators. Often where the

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lesions were extremely productive and the case at the outset seemed hopeless, radiation with interstitial implantation of radon gold seeds cleared up the lesion sufficiently to make the patient comfortable.

We have found gold seeds useful in the treatment of multiple recurrent nodular metastases following excision of breast carcinoma. When planted directly into the nodule, it seems to melt away. With us gold radon seeds have been found useful in radiating the following conditions: malignancies of the mouth and throat, rectum, bladder and prostate, vulva and such surface lesions where there is excessive growth of malignant tissue. We have found it useful in the treatment of carcinoma of the stomach, during operative exposure of the local lesion. Gold seeds are readily inserted through the cystoscope into lesions in the bladder, or better as Keyes has shown through a suprapubic cystostomy wound and often destroy the lesion completely or give marked relief and sometimes make an inoperable condition operable. Through the proctoscope direct treatment of rectal carcinoma with gold seeds is the method of choice. Dr. Binkley at Memorial Hospital reports excellent results from this method of treatment.

Even in hopelessly inoperable carcinoma of the larynx direct application of gold seeds to the local lesion often alleviates the acuteness of the symptoms. We have some cases that are very comfortable in spite of the severity of the lesion. In small malignant recurrences of cervix carcinomas already radiated, judiciously implanted gold seeds tend to heal the lesion locally, and keep the patient fairly comfortable.

In conclusion, radon gold seeds offer an effective, convenient, readily applicable means for treating large productive exposed lesions and those otherwise inaccessible to direct radiation.

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THE BARRAQUER CATARACT OPERATION AND ITS SIMPLIFIED FORM*

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The operation for the removal of cataract has undergone much modification during recent years, especially since the introduction of the vacuum suction method. This, to some extent, may be described as a physical method in contradistinction to the older methods, in which the knife was applied directly to the crystalline lens or its capsule.

The ideal in cataract extraction,[1] according to the leading ophthalmologists of the world, is one in which the affected crystalline lens can be removed with its capsule, leaving an untraumatized eye, with no vitreous loss, and with a round active pupil. Toward this end all progressive cataract operators are working.

There are two main types of cataract extraction operation, which occupy the attention of eye surgeons, viz, those in which the affected lens is removed by expression or squeezing out, and those in which the lens is extracted by some

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type of traction or pulling exerted upon it. In capsulotomy operations, the lens capsule is first incised. All capsulotomy operators then use the expression method for removing the cataractous lens. The expression method may also be used in certain operations in which the lens is removed in its capsule, such for instance as in the Smith-Indian intracapsular cataract extraction. While, therefore, the expression method may be used in both the capsulotomy and intracapsular methods of extraction, the traction method can be employed only in intracapsular operations, that is to say, it can only be used when both lens and capsule are removed together.

The traction method is accomplished, principally, by means of forceps or suction. Both methods have certain advantages in that the lens is delivered with the least amount of trauma and vitreous loss is lessened.

In the forceps method the capsule is grasped by a forceps and pulled away with the contained lens. The great danger in this procedure is that the capsule will often rupture.

The suction method,[2] now generally known as the Barraquer method, is performed by means of suction exerted on the lens, this being produced by an electrically driven vacuum pump, and the vacuum transmitted to the lens by means of a hand piece on the end of which is a vacuum cup which is made to enter the anterior chamber and is applied to the anterior surface of the lens in the pupillary space.

The vacuum is transmitted to the suction cup by a valve on the hand piece or "erisifaco" as it is called.

There is a vibratory action applied to the lens by means of a vibratory motion of the vacuum pump. It is important that the suction exerted upon the lens should be kept even and constant. This is effected by means of a constantly regulated vacuum of 60 cm. applied to the lens during the process of extraction as this has been found by experiment to be the proper amount of vacuum to produce the best results.

Arnold Knapp, of New York, states[3] that of all the operations devised for cataract extraction, the removal of the lens by means of forceps was by far the best, and that its only bad feature was the fact that only those lenses with capsules strong enough to resist the forceps could be removed by this method. The percentage of cataracts that can be removed by this method, according to him, is much less than one half. He gave[4] the percentage of burst capsules at 57 and 43 per cent of successfully removed cataracts.

Knapp further states that he has had no experience with the Barraquer operation; therefore, this operation cannot be considered in his comparison.

I agree with Knapp that the traction method is by far the best mode of operation; and, inasmuch as the forceps and suction methods both belong to the traction type, it will be well to compare the two.

With the forceps method, there is, as seen, a high percentage of burst capsules and when this complication occurs the operation becomes a capsulotomy with its usual drawbacks, such as post-operative interocular inflammation, and after-cataract or secondary cataract due to retention of lens corticle and remnants of the capsule.

The Barraquer operation has all the good qualities found in the forceps operation and, furthermore, it has a very low rate of burst capsules, this being only 3 per cent in my own series of cases.[5] This, therefore, gives the Barraquer method 97 per cent of successes while the forcep method has only 43 per cent of success.

The Barraquer suction method is performed in steps as follows:

1st. An incision with a conjunctival flap.

2nd. The removal of the lens with the suction cup by turning the lens over, a rather delicate procedure.

3rd. Performing a peripheral iridectomy.

4th. The placing of a suture in the conjunctival flap.

The Barraquer method, as practiced by its originator, has given most brilliant results. It requires great precision of manipulation and an expert knowledge of the technic. In the hands of the average operator the results have been so successful, and in practice certain modifications have been found necessary in order that the results should be constantly reliable.

The Barraquer method has been simplified by Dr. W. A. Fisher of Chicago, as follows:

1st. The incision with conjunctival flap.

2nd. The placing of a suture in the flap which is left untied until the lens has been delivered.

3rd. The delivery of the lens by lifting it direct from the eye *without turning it over.*

4th Making the peripheral iridectomy *after* the pupil is more contracted and suture tied which gives more support to the eye, and by which the possibility of loss of vitreous is lessened.

This simplified method has several advantages over the straight Barraquer operation, among which are most important:

1st. The removal of the lens *before* the iridectomy is performed gives the advantage of delivering the lens through a larger pupil as the pupil will always contract considerably during the iridectomy.

2nd. The tying of the suture *before* the iridectomy is made gives the pupil a chance to contract making it easier to perform, and at the same time furnishing greater protection against vitreous loss.

I have now personally been performing the modified Fisher-Barraquer operation for about two years and have found the results to be far better than with any other method. In 1927, in Shikirpur, India, I performed 506 cataract extractions, of which 137 were by the Barraquer method and it was found by comparison, during and after operation, that by far the best results were obtained with the Barraquer method, mainly a great reduction in vitreous loss and iris prolapse, obtaining a round, central, active pupil, and much reduction in traumatism.

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DISCUSSION

DR. E. G. LINN (Des Moines, Ia.): What particular advantage does Dr. Barraquer claim for the tumbling of the lens?

DR. OSCAR B. NUGENT: He claims that the eresiphake will not break loose from the lens as easily. In other words it is really a pushing process. I have performed quite a few in that manner, but I find that when I do (I don't think this happens when Barraquer does it, but it certainly does when I do it) the pupil is not as round after the operation as it is when I pull the lens straight out without turning it.

DR. LINN: Is there a trauma?

DR. NUGENT: I think there is a trauma to the underside of the iris.

DR. LINN: Do you select your cases with Barraquer?

DR. NUGENT: Not at all, except that I do not operate on pre-senile cataracts. In all other forms of senile cataract I make no differentiation. I take nothing but the Barraquer for that form of cataract.

F. L. WAHRER, Marshalltown, Iowa: My partner, Dr. Otis Wolfe, and myself have been performing the Barraquer intracapsular cataract operation for the last five years. Dr. Wolfe first presented the operation before the section on Ophthalmology at the Iowa State Medical Society four years ago, and later in an article in the Iowa Medical Journal and The Eye, Ear, Nose and Throat Monthly. The results have been extremely gratifying. The past operative reaction is very slight. Frequently we have been able to refract patients on the tenth day. One case was refracted on the eighth day. The visual results are very high. 20/20, even 20/15 being the usual rather than the exception.

The freedom from secondary inflammation is one of the chief arguments in favor of the method. Since Knapp presented his paper before the A. M. A. last year citing the frequency with which glaucoma and other inflammatory reactions occurred from retained

capsule, the argument for some sort of intracapsular operation is much stronger. Luther Peter has also stressed the importance of the capsule as a cause of secondary glaucoma. In no instance have we ever lost one single drop of vitreous by suction.

The only contra-indications are dislocated lenses and eyes in which the tension cannot be reduced prior to operation. We do a preliminary iridectomy seven to ten days before, to control this. The technic is rather difficult and is best accomplished by team work. In our own work we have perfected our technic until we both perform certain duties without hesitation. As Dr. Wolfe delivers the lens, I pull on the previously placed subconjuctival stitches immediately closing the wound.

Patients who have had both methods are particularly gratified with the results of the Barraquer Method in which no secondary operations are necessary.

Mrs. S. age 87, had the old operation ten years ago. Three subsequent needlings were necessary so that she could not be given glasses for six months. Vision 20/70, gradually failing. We performed the Barraquer Method four years ago in September and ten days after she was refracted. She still has 20/15 and J1 in this eye. She states that she reads all day and part of the night but sees very little with the other eye.

Dr. Oscar B. Nugent (Closing): Dr. Wahrer spoke of the preliminary iridectomy. I have had only one experience with it and that was very fine. I must admit that of all the Barraquer operations I have done I never had a cataract come out so beautifully or any more beautifully at least as that one did. I did not do the preliminary iridectomy myself. It was done out in California with the intentions of doing a combined operation, but on account of sickness of the patient's son the patient came to Chicago and decided to stay here and then had me perform the operation afterward. I have often thought that a preliminary iridectomy would be a wonderful asset to the Barraquer operation. There is only one drawback, failure of a rounded pupil.

As to team work, that is very essential. There are some points about cataract operations that are exceedingly necessary. An assistant who understands the technic of the operation is almost indispensable, especially when it comes to doing a Barraquer operation. I have a nurse who has been holding lids for cataract operations for sixteen years. She has probably seen more cataract operations than most specialists. She is very clever and I don't have to have a doctor help me. If I did not have such a nurse, I certainly should train an assistant in the precise duties.

As to burst capsules, they are very rare with the Barraquer operation. In India we had several men try the forceps delivery of the cataract. Dr. Poiellis of the Royal University of Madrid tried repeatedly to deliver a cataract with the forceps and failed. It seems that for some reason or other it couldn't be done over there. I have heard others say the same thing. However, some are donig the forceps delivery; of that I am aware; but in the 137 Barraquer operations that I performed in India in only 3 per cent were there burst capsules. In all, four burst capsules in 137 cataract operations.

As to vitreous loss, that has already been discussed. I have yet to lose vitreous during the process of delivering the lens. I have performed about 250 Barraquer operations and I have had not one case of vitreous loss during the process of the delivery of the lens. I have performed operations where vitreous appeared on the lens beore the erisifaco was applied, and in that case the Barraquer operation was not chosen. I have also lost vitreous. Don't misunderstand me, but the vitreous was lost in doing the toilet.

I believe this will be a very good thing for you to remember, doctor: The tying of the suture of the conjunctival flap before iridectomy has been performed holds the intra-ocular fluids in position and holds the eye in a more firm condition and the vitreous loss (this is where we lost our vitreous in trying to do the iridectomy or the toilet and not during the delivery) can be reduced. The doctor doesn't have that to do because he does the preliminary iridectomy and he has that all out of his way long before.

You misunderstood me when I spoke of the type of cataracts that I operate by the Barraquer method. I operate on cataracts at any stage, but I do not operate on pre-senile cataracts or soft cataracts. I find that about 50 per cent of these can be delivered with the Barraquer machine, but the rest will break the capsules very easily.

As to fluid vitreous, fluid vitreous is a contra-indication to any cataract operation. In other words it is not an ideal condition to be operating. However, I do the Barraquer in fluid vitreous just the same. I do not do it where the tension is more than 50. In that case I do the capsulotomy, the old operation. I learned that when I was over in India where we had nine-tenths of one per cent choroidal hemorrhages and these hemorrhages did not occur in high tension altogether. I had one case with a tension of 11 by the McLain's instrument and the patient had a choroidal hemorrhage. This is the saddest accident that can occur to any patient following an operation.

PHYSICAL THERAPY CLINICS

ZINC IONIZATION*

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The subject for today's demonstrations is zinc ionization. Among most physical therapists the term ionization indicates the use of the direct current—often called the galvanic current— to carry various chemicals into the tissues of the body. In the study of chemistry, you learned of the use of electrolysis in the manufacture of many of our modern chemicals, chief among which are: the elements sodium, aluminum, copper, chlorine, bromine, hydrogen, oxygen, and the compounds sodium hydroxide, potassium and sodium chlorates, and sodium hypochlorite.

Perhaps a better term for the method of treatment which we are going to demonstrate today would be zinc electrolysis, for its basic principle is the same as in these manufacturing processes. The positive pole repels the metals and similar electropositive elements, which on the other hand are attracted by the negative pole. These elements are usually found in the left end of a chemical formula, while elements in the right end of the formula, such as the iodine in sodium iodide, are repelled by the negative and attracted by the positive pole. We take advantage of these facts by saturating a pad or filling a cavity with an appropriate chemical, and connecting the electrode to the pole of the galvanic generator which will repel the element we wish to drive into the tissues.

Zinc is an excellent antiseptic and, in the form of the oxide and stearate, is considerably used as dusting powder. The trouble with such powders is that they do not penetrate. With zinc ionization we can drive the zinc into the tissues a couple of millimeters or more, which often is sufficient to get completely through the infected layer. Incidentally, it forms a thick coagulum with albuminous matter and thereby temporarily protects the raw surface from attack by bacteria, thus allowing time for the natural healing processes to take place undisturbed by bacterial action.

Zinc ionization is useful in the treatment of nearly all sinuses, a great many ulcers, and similar raw surfaces which are infected.

The first case which we have to show you is Kent C., a junior in the university. Four weeks ago he went home over the week-end, and found his family suffering from streptococcic sore throats. He joined in the festivities and soon developed a left middle ear infection. It opened spontaneously in a couple of days, and ran a stream of very thin bloody pus, which he absorbed with cotton pledgets an inch in diameter, changed every five or ten minutes. We had on hand an autogenous vaccine cultured from his father's throat, and used that. The ear cleared up quite satisfactorily at first, but a slight discharge has persisted. There is a hole of considerable size in the drum membrane so that we feel we will have no trouble in getting solution into the tympanic cavity. The nurse has just irrigated his ear until clean, and finished up with a plentiful quantity of the same 2% solution of zinc sulphate we will use. We have him lie on the table in a comfortable position on his side, with a pillow under his head, and the affected ear up. A hard rubber speculum is

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placed in the ear, and inserted into that an electrode of commerically pure zinc, which is connected to the positive pole of the galvanic generator. I made this electrode from a worn-out zinc rod from an old style door bell battery. It had its binding post already at the top and all I had to do was grind it on an emery wheel to a square cross section and taper it to fit the hard rubber speculum. The negative pole is connected to the tube handle lying on the table, covered with a couple of layers of absorbent paper (a paper towel, toilet paper, or even newspaper) moistened with water or a 2% salt or soda solution, and have the patient take hold of it with one hand. Some advocate for the negative pole a moist pad over the mastoid of the same side, claiming it avoids the causing of dizziness. This has not always been the case in my experience, and I feel that very gradual changing of the current strength is a much more important factor. Also, the tube handle is so much more convenient.

With a medicine dropper, now pour into the speculum a 2% solution of zinc sulphate, until it appears around the speculum and nearly ready to run down over the cheek. Have the patient turn his head so that the solution will not escape, and so that the speculum stands nearly vertical. Fasten a safety pin through the patient's clothing at the shoulder and around the wire so as to hold it steady in position.

The current is turned on very gradually, and the patient is asked if he feels it. Soon he reports a tingling in the ear. The current is increased until he tells us it is about as strong as he can comfortably stand. The milliampere meter now reads four milliamperes. The treatment is continued at least 30 minutes, although an hour would be better.

Note, from a later clinic: (this patient received another 30 minute treatment in three days, and another of 50 minutes a week after that, following which his ear healed promptly, and he returned to his studies apparently as well as ever.)

We have a very fine generator made by one of the leading manufacturers, costing, with accessories, nearly $500.00. It will produce fifteen different varieties of currents, which, properly selected, will produce a large number of different effects on nerve and muscle tissue. We use it for our zinc ionization because it is very simple to control, and adjusts very smoothly to the exact current strength we wish, whether one or one hundred milliamperes. Some such generator is absolutely essential to a well-equipped physical therapy department. Do not postpone the use of ionization until you can afford to buy such a generator. Get four or six ordinary no. 6 dry cells, an exhausted flashlight battery, a few assorted tin cans and some wire. A piece of lamp cord untwisted will do, although the larger electrical stores carry a smaller and more flexible wire similar to fixture wire in size. Have several pieces three to five feet long, and on their ends fasten spring clips, this material may be purchased for a very moderate sum. With the aid of a hatchet, and a pair of shears dissect the flashlight cell, and clean up the zinc with sand paper or steel wool. It is not easy to get wire or rod made of pure zinc, but an old flashlight cell may be easily obtained. In treating an ear such as this, cut a strip an eighth of an inch wide and as long as the height of the cell. Slip it into the large end of the rubber speculum until it just comes short of protruding from the small end, and then bend it at right angles so that it will rest on the rim of the speculum and the end of the zinc will not project so as to touch the skin and cause a local burn. The spring clip on one end of the wire is connected to the end of the zinc projecting from the rim of the speculum, and to the center or positive pole of one of the dry cells. The outer or peripheral pole, which is the negative, is connected with the positive pole of the next cell, using a short piece of insulated wire for the purpose. Connect all four cells in this way, which is what we call connecting them in series. Another wire with spring clip is connected to the free negative pole and to the tin can, which makes a very good substitute for the tube handle. We arrange the ear electrode as above described, cover the can with moistened paper, and have the patient himself turn on the current by touching a finger tip to the moistened paper, and gradually increase the current by adding other

fingers and bringing the total length of the fingers and the palm of the hand in contact, thus regulating the current to the maximum which is comfortable.

Our next patient is Billy B., 12 years old. When he was two years old he had scarlet fever, and has had intermittently suppurating ears ever since. Three years ago, he had a left mastoidectomy, following which the usual treatment with irrigation and drops was not successful in curing the infection. About a year ago we treated his ears with zinc ionization according to the method just demonstrated. The right ear cleared up fairly soon, the other ultimately, although it was a very tedious case. He was treated two or three times a week for two and a half months. At the end of this time his ears were dry, though there was considerable dried epithelium and wax present. He was kept under observation for two more months during which time both ear canals shed a complete coat of skin several times. He did not return until two months later complaining that his left ear was running again. Several treatments apparently cleared the condition and again we lost sight of him. Now, he is back again, and I am presenting his case to you merely as a contrast to the other patient. Not all cases of otitis media can be cured by zinc ionization. Polyps, cholesteatoma, and similar growths obviously cannot be so removed, although they might be destroyed by galvanism or diathermy, as has been so beautifully demonstrated by our good friend, Dr. A. R. Friel of London, England.[1] However, in a case which is due to simple infection, and when there is a hole in the drum large enough to allow solution to enter freely, ordinarily there should be no difficulty in curing it with zinc in much less time than by any other method. We made our mistake with Billy when he returned with the first recurrence. We should have sent him over to the ear department for a thorough examination instead of presuming that his condition was the same as when we last saw him. You, in your private practices, will of course examine frequently the ears you are treating, but if you are not satisfied with their progress, take them to an ear consultant rather than waste time on a prolonged course of treatment without results. We will have the otologist look him over, show us what he finds, and together we will decide how to reduce the pathology to a simple infection which we can cure with zinc ionization

Our next is a private case, Mrs. J. H. C., age 28, who reported a number of attacks of "indigestion," extending over the past several years. Four and a half months ago she had an attack more severe than usual and was sent to the hospital with a diagnosis of chronic and acute appendicitis. The surgeon recognized in addition a very bad generalized pelvic infection, and at operation excessive pus and exudate were found. This condition was cleaned up as well as possible and drained. Several days after operation a fecal fistula developed.

She was in the hospital nearly two months, and when discharged, the fistula was about three millimeters in diameter, and could be followed with a probe, to a depth of only one and a half centimeters. It was expected healing would continue, and in fact the skin did close over. A week or so later, after several days of increasing tenderness, with local inflammatory symptoms, the fistula broke open again, and discharged considerable dark material with a fecal odor. This relieved the pain and swelling, and the sinus again attempted to heal. In spite of the best surgical care this has happened several times in the last two and a half months, and now we are asked to treat her with physical therapy.

Let us first discuss the pathology present, then consider what must be accomplished and finally decide how we may do it.

This sinus began as a cylinder of plastic exudate surrounding the drainage tubes. The intestinal wall, being thin where adhesions had been separated, broke down and spread its contents along this tract causing a low grade mixed infection. Then organization and very likely some attempt at fibrous tissue formation took place. Now we have an opening barely admitting a probe, which we can insert less than two centimeters. This is very painful, and various caustics have been tried in vain, in the attempt to stir up sufficient reaction in the tissues to cause healing.

Our task is to devise some means to destroy the abnormal and infected lining, sterilizing the tract, and induce it to heal from the bottom up, instead of from the skin down, as seems to be its present tendency. The surgeon is baffled by the tortuosity and probable diverticula present; besides, his manipulations are so painful as to require general anesthesia.

In the galvanic current applied as zinc ionization, we have an excellent agency to do all these things required. The electrolytic action of a strong current will destroy whatever tissue it is concentrated in, while the zinc carried into the tissues will disinfect everything it penetrates, which it does wherever we are able to inject 2% zinc sulphate solution.

Our generator being busy, we will demonstrate the home-made outfit described a few minutes ago. As we need a much heavier current than we used in the ear, we will use in place of the four dry cells an old forty-five volt B battery, also a large sheet of black tin, or the side wall of a tin can. It is covered with a paper towel, folded to fit, moistened (not very wet) with water, salt solution, or better 2% sodium bicarbonate solution, and all excess is squeezed out. We now have the patient arch her back and we slip this moistened electrode under her buttocks and connect it to the negative pole of the B battery.

For these heavy treatments, and in order to be able to duplicate current strength, it is almost necessary to have a milliammeter. One may be purchased from an electrical dealer (such as is used in radio sets and tube testers), for eight or ten dollars.

We swab out the sinus as clean as possible, fill it with the zinc solution, insert into it, as far as we can, a strip of zinc an eighth inch wide from the flashlight cell. We use it bare because we wish to destroy the entire pathological lining of the tract, especially at the skin end.

We fasten the wire to the zinc strip and put a gauze pad under the spring clip to support it and keep it from contact with the skin. Steady the whole in place with a large strip of adhesive plaster across the spring clip and fasten the other end of the wire to the milliammeter. Snap a third wire on the other post of the meter and we are ready to turn on the current by having Mrs. C. arch her back again while we snap the other clip on the twenty-two volt positive post of the B battery, and have her let down slowly on the moist pad.

The current is turned on to 70 milliamperes and the patient reports a stinging sensation in the sinus although she is not uncomfortable. We let it run for 25 minutes, occasionally inquiring how it feels, dropping a little zinc sulphate on the opening of the sinus and noting that the meter gradually drops off to forty milliamperes. This is probably due to polarization of the venerable battery, though it might be due to increased resistance and polarization of the tissues being treated.

Some one has asked how we can regulate the current strength with this extemporized outfit.

If the patient complains as we now have her connected, we can reduce the effective voltage by putting our bundle of No. six dry cells in the circuit backwards. Connect the positive pole of the six dry cells to the positive pole of the B battery, and put the spring clip we have just taken from the positive pole of the B battery on the negative pole of whichever dry cell gives us best results. Use as strong a current as the patient will tolerate.

We might roughly calculate the dosage in this treatment, as follows: current began at seventy and dropped to forty,—let us call it an average of fifty milliamperes. Multiply by twenty-five minutes, time of treatment, gives us twelve hundred and fifty milliampere minutes, the dose administered. This figure might be useful in treating other similar cases, though I feel certain we will never find two cases just alike. Physical therapy is just like the other branches of therapeutics. Human nature is so variable that you cannot reduce therapy to mathematical exactness, but must always decide the dosage

according to the many variable factors in the patient, your experience, and your best medical judgment.

At the end of 25 minutes we have her roll off the pad to shut off the current gradually, as disconnecting a wire would produce an unpleasant shock. Then we disconnect and remove the electrode, and dress the sinus with a large sterile pad. We give her a supply of the pads, instruct her how to change them and tell her to return next week, if she does not suffer in the meantime.

The student assigned to our next patient will read his history: Case no. 292,594. Mr. M. J. K., age 34. In Sept. 1924, patient noticed pain and stiffness in right wrist. Part swollen and red. Lasted one month, in meantime right shoulder became involved with soreness and partial loss of function. The right foot was next involved followed by the right knee. All joints returned to normal except the knee, which became stiff; motion very slight, painful and swollen. In 1926 he took treatment at Magnetic Springs with little relief. In May, 1928 the knee was aspirated and pus found. Incision and drainage. On July 15, the knee again opened and he was taken to another hospital, operated and rubber drain inserted. Each time thick, yellow pus was obtained. Opened again and again. Drained a quart. Several incisions still draining. Four sinuses remain. Seven years ago patient had gonorrhea, which appeared to clear up. In 1925 he had epididymitis.

Uusal diseases of childhood. Always healthy except for gonorrhea infection in 1922.

Admitted to University Hospital January 5, 1929.

X-ray shows an infection process of the knee joint with absorption of the joint cartilages and erosion of the outer aspect of the femur. There isn't much of the cartilages left and it is problematical how much motion he will have when he recovers. However, that is the orthopedists problem.

Dr. E. H. Wilson, orthopedist, gives as his opinion that there is apparently no evidence of tuberculosis because of lack of bone atrophy, or destruction. The reaction seen here is one of active new bone formation as is seen in pyogenic infections.

Shortly after his admission, the biggest abcess was opened and tissue removed. The pathologist reports:—Gross: The specimen consists of a piece of tissue covered on one side by squamous epithelium and several other pieces of white, friable tissue.

Microscopical examination reveals more or less circumscribed areas of necrosis, without definite tubercle formation.

When we first saw him on Febr. 25, we found four sinuses, two above and two below the joint, two on the internal and two on the external aspect. The upper internal one was really not a sinus but a wound eight or ten centimeters long, gaping widely, angry, inflamed and tender, from which rolled quantities of greenish yellow pus. The pocket extended upward in the soft tissues to the middle of the thigh, and was very tender throughout its course. We easily expressed a couple of ounces of pus. The other sinuses also communicated with pockets of pus.

We began treatment with ultraviolet and diathermy, which we will not discuss here except to remind you that a large percentage of patients, probably more than half, need more than one physical agency in their treatment. Don't depend on one agency if more than one will get results quicker and better.

Two weeks ago, on Feb. 27, we treated this large pocket with zinc ionization, using fifteen milliamperes for twenty minutes. The flow of pus doubled next day, and then decreased until it was much less and much thinner than before treatment. For awhile it was serous in character. Now, while there is considerable pus still discharging, the wound is much smaller and healthier looking. There is hardly any tenderness—we can press most anywhere without

illiciting pain. Apparently the big pocket is closing down. Two weeks ago pressure, half way up the thigh, expressed pus from the wound. Now it is necessary to move down four or five centimeters before we get it.

Today he will be given another treatment similar to the first, the pocket irrigated well, finishing with the zinc solution as in the ear, thus assuring contact with the maximum area of cleaned surface.

As the wound is wide open and we wish it to close we must, in this case, protect the tissues from direct contact with the electrode. Our hard ear-speculum and its zinc electrode will also do splendidly for this purpose. We arrange a moist pad under the buttocks as before, connected to the negative, insert the speculum and electrode connected to the positive pole, steady them with a strip of adhesive plaster, fill the speculum with the electrolyte, and gradually turn on the current. Soon we reach fifteen milliamperes, the maximum he could stand during the first treatment, and he tells us he barely feels it. We reach thirty millimperes before he says enough, and continue it for 20 minutes.

In a couple of days we will treat one of the other sinuses, all of which have very small openings, with the bare electrode, as we did in the case of Mrs. C., only we will use it but 20 minutes. After we get around to all of them, if we get no severe reactions, we will repeat treating two at a time. If the need for destructive action appears, we merely need increase the time or current strength, or both.

I believe we can clean up this infection, just as we have many others, though it may take a long time. Even if his knee is stiff—how much better than to loss the leg. And besides, after we clean up the infection, Dr. Wilson may be able to do an arthroplasty, though the knee is a mighty poor place to try it.

Our last case, No. 291,354, is Miss A. E. B., age 23, a graduate nurse. Her trouble began a year ago with an attack of pain in the right elbow, which became inflamed, swollen, and stiff. This wa sthe only attack of such nature she had ever had. Tonsils and adenoids were removed some years before.

A diagnosis of acute arthritis was made and she was given the usual treatment. A splint was applied to relieve the pain and she was later allowed, after five weeks in the hospital, to go home.

The joint became absolutely stiff and thirteen weeks ago an arthroplasty was done. It was apparently successful, but after a good many days pain and swelling again developed. She was readmitted five weeks ago and a diagnosis of infection of the elbow joint was made. A course of ultraviolet radiation and diathermy and cod liver oil failed to check the infection, and seventeen days ago the abcess was opened under ethylene, evacuating considerable pus, which contained staphylococcus aureus. An autogenous vaccine was made, but has no seemed to help much.

Here we find a painful joint, swollen to twice normal size, and with hardly any motion. There is a sinus on the external aspect, and a much smaller one on the internal aspect. We will treat the outer one today, in much the same manner as in the other patients.

We seat her in the chair, with her arm resting horizontially on the table, so the sinus is uppermost. Clean out the sinus and apply the electrode as we did with Mrs. C. For variety's sake we will use a heavy tin negative electrode as big as my hand. We bend this to the proper curve to fit and cover it with a quarter to a half inch of cellucotton, moisten it with 2% soda solution, squeeze out the excess, and bind it on the upper arm with an elastic bandage. Turn on the current gradually and ask her to tell us when it is strong enough. Now she stops us at five milliamperes and we will let it run for a while. In ten minutes she is complaining of pain and is very nervous and fidgety, although there has been no change in the current strength. As the sinus here is much smaller than the others we have treated, perhaps this is enough, so we will shut off the machine and remove the elec-

trodes, apply a plain sterile dressing, and send her back to the ward.

Notes, from later clinics. (A day's profuse flow was followed by a marked lessening of the discharge. The pain and swelling disappeared in three weeks, leaving the joint and adjacent parts nearly down to normal size; motion much improved. She was discharged to return to the dispensary for dressings. Improvement continued for a few weeks; then we lost track of her.)

In conclusion—we have shown you a number of different conditions in which zinc ionization is the method of choice for sterilizing simple infections, and have demonstrated the appropriate technic. We have tried to show you how to select cases and have also exhibited a failure or two, hoping to save you from the pitfalls into which we fell. You have seen how very simple and inexpensive apparatus may be extemporized (for galvanic treatments) and used as successfully as the finest factory made machinery.

The "galvanic box" which I designed and had built in the medical shop can be built at a cost of $30.00. But you cannot extemporize generators for high frequency, ultraviolet, or the wave currents. Therefore—begin with the galvanic, which the authorities claim to be the most useful of all the electrical agencies.

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[1]See Article in February Number, Archives Physical Therapy, X-Ray and Radium P. 45, 1929.

INTERNATIONAL CONGRESS OF PHYSICAL THERAPY

The January 20 letter of your Belgian correspondent describes the celebration of the twenty-fifth anniversary of the Antwerp Physical Therapy Society (THE JOURNAL, March 16, p. 913). He mentions "Dr. Gunzburg, who had the honor of calling the first International Congress of Physical Therapy, which met in Liege in 1905, and who will preside over the next international congress, which is to convene in 1930 in the same city."

This statement would seem to raise a question of fact as data on file here show that the first International Congress of Electrology and Radiology was held in Paris in 1900.

As for the next International Congress of Physical Therapy, to be held next year, information received from Dr. J. Gruber, professor of physical therapeutics at the University of Jena, would seem to propose that its meeting place should be in a country not involved in the late war, preferably either Holland or Switzerland.

In the interest of scientific advancement of methods of treatment by physical therapy, the latter would seem the more advisable plan as, also, would be a consolidation then and there of the separate congresses, common to our European confreres, on balneology, spectral rays, electrology and all other physical measures for disease and injury.

A. B. HIRSH, M. D., New York.
J. A. M. A. 92: April 6, 1929.

MOYNIHAN A PEER

The signal honor of a peerage has been conferred on Sir Berkeley Moynihan. This is the first occasion in which the honor has been conferred on a practicing surgeon and Moynihan is the second surgeon to receive it, the first being the late Lord Lister. To his merits as a great surgeon he units a gift of lucid exposition and oratory unapproached in the profession. His contributions to debates in the house of lords, particularly on medical questions, should therefore be most valuable.
J. A. M. A. 92: April 6, 1929.

EDITORIAL

ARCHIVES OF PHYSICAL THERAPY, X-RAY, RADIUM

Eighth Annual Meeting,
November 4, 5, 6 and 7, 1929,
Hotel Sherman,
Chicago.

LOCAL DIATHERMY: INFLUENCE ON INTRAMUSCULAR SUBCUTANEOUS ABSORPTION AND KIDNEY SECRETION

Diathermy is at present occupying an unusual position in that it is constantly being questioned as a therapeutic measure of merit. Within the past few weeks, an article by Friedman dealing with a phase of diathermy appeared in the *Journal of the American Medical Association*. The conclusions raise a doubt concerning certain established effects of this agency. Contrary to expectations, this negative report has thus far not exerted the stimulating influence that was anticipated. No co-ordinated or concerted formal reply has thus far been made by those most capable to refute any part of this published report.

Friedman's* investigation is probably the most scholarly and dignified indictment of one of the cardinal, physiologic effects of diathermy, namely *hyperemia* and its corollary, *absorption*. On the theoretical assumption that "if diathermy induces local hyperemia one might expect diathermy to accelerate absorption of substances from subcutaneous and intramuscular tissues," and by the same token, "demonstrate increased kidney secretion," attempt was made to study the local influence of a diathermic current on the well-known pressor drug, *epinephrin*. No noticeable rise in blood presure followed diathermization. Absorption apparently was influenced to a negligible degree. Indeed, in one instance, massage of the diathermized limb, by the method of Luckhardt and Koppanyi, produced a greater rise in blood pressure, compared to that of the untreated limb. The pressor handicap of this drug is apparently sufficient to overcome the active hyperemia that was proven to be artificially evoked by diathermy.

The second part of this interesting research, whereby tissue injected with epinephrin and methylene blue was diathermically treated for an hour, then excised, washed and injected into other animals to test for the remaining potency was a shrewd experiment, but fell short in its conclusiveness to prove that any permanent absorption could be expected with a single one hour's treatment. In this connection an interesting confirmation of already recognized phenomena developed. It was found that adipose tissue acted as a barrier and that the extract from the treated animals with a lesser adipose covering, induced a proportionately lower blood pressure-rise than the controls with a heavier adipose layer. Electrophysiologists have long recognized the dielectric phenomena of fat.

The studies on the absorption of subcutaneously injected phenolsulphonphthalein carries the same potential fallacy, since it was anticipated to influence absorption by limited diathermization, namely for a period of one-half hour. This experiment has some illuminating points not emphasized by the author. For example, Table 1, in the report, calls attention to three experiments where, when the part was diathermized to the production of local edema, absorption was materially retarded. This is in line with the recognized fact that excessive heat produces metabolic depression. It must be remembered in this instance also that the skin of dog compared to human, is the least ideal for experimentation with diathermy. It is more highly resistent to high frequency currents, and

has a richer fur integument—handicaps, that the author himself has in part noticed. Where edema was observed, the author points out, "there appears to be a marked retardation of the rate of absorption," and "these results carry the suggestion that the rate of absorption varies in some inverse manner with the adiposity of tissue."

In spite of this, the author has proceeded with another problem the conclusions of which, had it been correlated with the analysis of his previous experiments, would have theoretically recognized the inevitability of failure—a fact actually confirmed by Friedman's later studies. Bismuth hydrate and *oil* (italics are ours) and bismuth potassium tartrate in *oil* was intramuscularly injected in both hind legs of a series of dogs, one for diathermization and the other as a control. The absorption effect that followed after a prolonged series of diathermy was, if anything, slower in the treated, than in the controlled parts. The ineffectiveness of diathermy in this instance was probably due to the shunting of the high frequency current by the oily medium because of its dielectric qualities. That the controlled limb had an absorption rate equal to that of the treated one may be attributed to the fact that the body in general was influenced. This is a phenomenon well recognized by clinical observers and substantiated by the author elsewhere in his paper. He says, "the changes in intramuscular temperature were quite independent of the variation in rectal temperature, frequently the two going in opposite directions." Fourteen years ago the late Sir Lewis Jones** also called attention to this manifestation by quoting an earlier contribution of De Kraft, that "venous congestion is relieved because of the marked activity of the arterial circulation. Anemia of the splanchnic area ensues . . ."

Friedman frankly confesses that "at present it is hardly possible to orient our results with the observations of other workers." Nowhere is the dissimilarity of results frequently more variable than when we attempt to link up some of our clinical findings with that of the laboratory. We refer in particular to studies of gastric motility and kidney function. The negative results obtained by Friedman in his studies of kidney secretion is a case in point, where the laboratory-animal method has yielded negative results against positive findings of the bedside method. For example, while there is disagreement among investigators as to the influence of gastric secretion, the motility and temperature of the stomach has been definitely proven to be augmented following diathermization. Under x-ray control Ludin† studied a series of patients suffering from gastroptosis, ulcers and tuberculous peritonitis, and was able to observe deeper and stronger peristaltic motion. The emptying time was shortened from one-half to two hours against that observed in controls. Kowarschik in his book (1928) reports several cases of pylorospasm in which diathermy produced favorable changes—changes that were checked by x-ray pictures and improvement of symptoms. The normal stomach is not influenced. Although Friedman was not able to produce extra secretion from the kidney in normal dogs, Nagelschmidt in his book (1926) has reported favorable influence in a series of six patients with chronic nephritis in whom he observed reduction of pathologic urinary findings following the application of diathermy. The normal kidney of the dog apparently is also not influenced.

Analysis of the many angles of Friedman's painstaking and scholarly investigation convinces one of its permanent value. It is, in spite of its negative conclusions, an indirect confirmation that diathermy produces profound to slight deep heating effect as attested by him that he was able to invoke variable degrees of heat in the deep tissue ranging from 0.8°C to 9° C. He has thus been able to prove his first premise that hyperemia is a characteristic of diathermization. In recent years this has been a mooted question in America, and therefore helps to conclude the mild polemic initiated by the researches of Bettman and Crohn.

Friedman's work merits laudation. Whereas he has failed in some of the finer details of his investigation and has left many loopholes for argument, on the whole the effort was extremely worth while. From the laboratory must come more scientific reports to help rationalize

methods which clinical experience often first finds valuable. —D. K.

*FRIEDMAN, MAURICE H. *Local Diathermy: Influence on Kidney Secretion and on Intramuscular and Subcutaneous Absorption.* Jour. Amer. Med. Assoc., Vol. 92, No. 20, May 18, 1929.

***Diathermy*—Lancet—1918.

†LUDIN, L. *"Klinische und Expermentelle Untersuchungen uber der Einwirkungru ausseoer lokaler Warmeapplicationen auf die Funktion des Magens."* Zeitsch. f. d. ges, Exp. Med., 1919, H 1-2.

MASSAGE

Personal observation leads the author to think that the present era of enthusiasm in the uses of mechanical and electrical agents in physical therapy has led to an oversight and neglect of massage. Due to this oversight many patients, who might receive great benefit from the proper use of massage, are not getting results which the patient might rightfully expect and the physician is greatly disappointed. This is one of the oldest agents of physical therapy and has been used not only by the medical profession, but by the laymen as well. The tired business man gets great satisfaction from massage following a turkish bath and large numbers of these men seek this form of treatment frequently.

So far as the uses by the medical profession are concerned, we wish to call attention especially to its importance in myalgias, post-traumatic muscle sprain, paralysis and practically all fractures.

Massage, of course, should always be preceded by heat in some form. It is our opinion that radiant heat from the 1500 watt blue electric light is preferable to other forms.

The work of Sonne,* as recently published in the Archives, calls attention to the value of luminous rays, not only for their heat value but for their general stimulating effect. Sonne points out in this article that the radiant heat or luminous rays have considerable more penetration into the subcutaneous tissues than do other forms of light, especially the infra-red. These experiments discredit the commonly accepted idea, which has prevailed in the past, that the infra-red was especially indicated where deep penetration was desired. The luminous rays, as proven by Sonne, are the ones indicated in lesions below the skin surface. By application of luminous rays to the part before massage is applied, hyperemia is produced, the tissues become relaxed and in this matter are more amenable to the mechanical movements of massage.

Massage, as it is well known, is applied in several different ways—stroking, tapping, kneading and rolling. When the part to be treated is tender to pressure, and irritable, only the lightest massage should be used, gradually increasing the pressure and manipulation by other methods of massage as the tissues tolerate it.

It has been frequently observed by the author, that where diathermia alone or radiant heat alone or infra-red alone have failed to give the patient the desired improvement, where massage was combined with these other methods of treatment, improvement began at once. Massage produces movement of the tissues, one upon the other, making them pliable and soft and reduces the stiffness which is present in so many cases. It seems to us that the ideal method, especially in fractures, would be to begin massage at the earliest possible moment and to accompany this with passive motion as soon as it is practical. It is much easeir to prevent fixation of the soft tissues and consequent immobilization of the joint near the fracture than it is to get rid of this stiffness after it has occurred. —A. F. T.

*Sonne, Carl, Investigations of Luminous Rays and Their Mode of Action, Archives Physical Therapy X-Ray Radium, X, 3, Mch., '29, pp. 93-104.

THE STUDENT'S LIBRARY

BOOKS RECEIVED

This column is devoted to acknowledgment of the books received. Such acknowledgment must be regarded by the sender as sufficient recognition of the courtesy until time and space permit selections to be made for review.

PHYSICS FOR MEDICAL STUDENTS. By *Sidney Russ,* D. Sc. (London) F. Inst. P., Joel Professor of Physics, The Middlesex Hospital Medical School, Physicist to Middlesex Hospital, London Fellow of the Royal Society of Medicine. E. & S. Livingstone, 17 Teviot Place, Edinburgh, 1928.

"LIGHT AND HEAT IN THERAPY," with a chapter on "Foam Treatment.' Being the Proceedings of the Second International Conference on Light and Heat in Medicine and Surgery, University of London; Oct.-Nov., 1928. Authors: *Sir Henry Gauvain,* M. D.; *C. B. Heald,* M. D.; *W. J. O'Donovan,* M. D.; *W. Kerr Russell,* M. D.; *Albert Eidinow,* M. B.; *M. Weinbren,* M. R. C. S., *C. Conyers Morrell,* M. D.; *F. Talbot,* M. R. C. S.; *T. C. Angus,* A. M. I. E. E.; *Franz Nagleschmidt,* M. D., Berlin; *A. J. Cemach,* M. D. Vienna; *W. Flaskamp,* M. D., Erlangen; *M. J. Dorcas,* Cleveland, U. S. A. The Actinic Press, Ltd., London, England.

"THE VERTEBRAE." Roentgenologically considered. By *Arial Wellington George,* M. D., and *Ralph Davis Leonard,* A. B., M. D. Edited by *James T. Case,* M. D., 203 roentgen-ray studies, 13 clinical illustrations and one colored plate. Price $10.00. Paul B. Hoeber, 1929.

LEHRBUCH DER STRAHLENTHERAPIE. By *Professor Dr. Hans Meyer,* Bremen. Band IV; 1. Teil (Seiten 1 bis 766) Die Strahlentherapie in der Gynakologie, by *Professor Dr. C. J. Gaus,* Direktor der Universitats-Frauenklinik Wurzburg, with 153 illustrations in text and 6 colored plates. Band IV; 2 Teil (Seiten 767 bis 1394) Die Strahlentherapie in der Gynakologie, *Professor Dr. C. J. Gaus,* Direktor der Universitats-Frauenklinik Wurzburg, with 262 illustrations in text and 11 colored plates. Urban and Schwarzenberg, publishers, Vienna, 1929. Paper binding G. M. K. 98; cloth G. M. K. 108.

"LES RAYONS ULTRA-VIOLETS EN THERAPEUTIQUE." By *Jean Saidman,* M. D. Second edition. 100 Francs. 840 pages, 192 illustrations. Gaston Doin Et Cie, Editeurs, 8, Place De L'Odeon, Paris. 1928.

"A SURGICAL DIAGNOSIS." By *J. Lewi Donahuser,* A. B., M. D., F. A. C. S., Clinical Prof. of Surgery, Albany Medical College (Union University). Associate Surgeon, Albany Hospital; Attending Surgeon, Child's Hospital, Albany. 797 pages, illustrated. New York City., D. Appleton & Company.

BOOKS REVIEWED

GOITER PREVENTION AND THYROID PROTECTION. By *Israel Bram,* M. D. 327 pages, with illustrations. Cloth. Philadelphia: F. A. Davis Company, Publishers 1928.

This book is a popular exposition on the problem of goiter, its prevention and its protection. Opinion is still far from unanimous among the medical profession as to the logical method of dealing with this very important problem. The surgeon and the internist are far from agreed as to what portion of the problem belong to each. It is natural, therefore that a large mass of popular misinformation should have developed around this situation, from which the pseudo-quacks and the publicity seekers have reaped a profitable harvest. The patient has paid by continued suffering because he has been the grist between the millstones of the contending factions.

The author, one of the foremost students of the problem, points the way out of this chaotic state in a clear and coherent manner. He indicates that goiter in many instances is a preventable disease when treated in time and with intelligence. The book is a splendid exposition of the subject and is written in a manner comprehensible to the intelligent layman. The physician will therefore find this book of great service, not only for his personal information, but also when placed in the hands of his patients.

The author has also included at the end of the book a comprehensive and popular exposition on the thyroid and other ductless glands in their "relations to the physical and mental welfare of mankind, so that teachers, physiologists and sociologists will find in this work material of considerable service in their respective fields." To the physiotherapist this book will be a great aid as it will better permit him to see the reason for some of the beneficial effects obtained by physical means, the fallacies of certain fadistic treatments, and some of the limitations of drug therapy.

No modern physician can afford to be without this valuable book. It is an intelligent guide to one of the most complex and yet debatable therapeutic problem of modern medicine.

KURZER LEITFADEN DER PHOTOCHEMIE IM DIENSTE DER MEDIZIN, INSBESONDERE DER LICHTTHERAPIE UNO PHOTOPHYSIOLOGIE. *Von Prof. Dr. phil et. chem. J. Plotnikow,* Direktor des-chem. Institutes an der technischen Fakultat der Universitat Zagreb, o. M. der Faraday Society in London, etc., etc. Mit 40 Abbildungen—1928 Georg Thieme, Verlag, Leipzig.

This interesting volume is from the pen of a noted authority on photochemistry who, in his preface, confesses that he was prompted by "friendly medical colleagues" to write a popular exposition on the fundamental facts of photochemistry as they are related to phototherapy and photophysiology. The purpose of the book is to demonstrate the relationship between radiation therapy as now utilized in medical practice, and the photochemical reactions that follow its absorption. According to the author, contemporary teaching has not kept pace with the progress in photobiology—a study that has become recognized for its important contributions in many departments of science. He has therefore attempted, through the medium of this small volume to introduce the subject of photochemical reactions in the form of a popular exposition to the modern student of medicine. The data incorporated in these pages are decidedly original to the average medical reader, for they convey the point of view of the pure scientist —the photochemist.

Briefly the book is made up of eight chapters preceded by an introduction and a short bibliography dealing with problems of what might be termed medical photochemistry. The first chapter concerns itself with a review of the general characteristics of radiation energy. The entire range of the electro-magnetic spectrum, from the longest electrical waves to that of the shortest extra terrestrial *gamma* rays are considered. The energy value of each respective region is emphasized. It includes a discussion of the so-called "death rays," that is, ultraviolet rays of shortest wave length (2000 A° to 1000 A°). These rays, according to the author, are the most chemically active and photolytic in the ultraviolet spectrum, hence the picturesque name of death rays. They are, however, of slight practical value because instruments do not as yet exist for the purpose of therapeutic application.

The second chapter concerns itself with the problem of photoactivity. Among other problems the author discusses the theory of valence in relation to photochemical process, as well as a detailed consideration with reference to photolyses, polymerization, and reaction of synthesis and degradation. This chapter is well illustrated by chemical formulas which are somewhat technical in character; nevertheless, the reading of it will be found to be decidedly stimulating and profitable.

The third chapter deals with problems of Absorbtion, and concerns itse]f with a consideration of the laws of Von Grotthus, Vant-Hoff and the author's personal interpretations of these laws. The practical applicability of these laws are illustrated by a wealth of facts and many examples.

Light as a catalytic agent, and its theoretical possibilities is dealt with in the fourth and fifth chapters. This, by far, is the most fascinating section of this most interesting book. A large series of photoactive elements and drugs are enumerated and their photoactive and catalytic possibilities are discussed in great detail. These two chapters are unusually rich in scientific data and contain an unusual amount of practical information of value to the medical practitioner and photophysiologist. It opens up an avenue of speculation for laboratory experimentation of great interest to the experimental student in photobiology. The possibility of utilizing phototherapy to activate inert chemicals, drugs and foods by radiation is a fascinating speculation that may be realized in a practical manner in the near future. The author definitely points the way in no uncertain manner.

The last three chapters are somewhat technical in character, although no less interesting, and deal with the characteristics of light sources, (artificial and natural) their various methods of demonstration and measurements, and the influence of temperature on light reaction. A recapitulation of the laws of absorbtion and the indication of the close relationship of the Bunsen-Roscoe law to it is the concluding feature of this unusually interesting book.

This volume occupies the enviable position of the most authoritative exposition on photochemistry in relation to phototherapy that has thus far been published in the last decade. The medical profession is highly indebted to the author for this scholarly contribution. This book is highly recommended.

INTESTINAL TUBERCULOSIS, ITS IMPORTANCE, DIAGNOSIS AND TREATMENT. By *Lawrason Brown,* M. D., Chairman of the Medical Board of the Trudeau Sanatorium, Saranac Lake, N. Y., and *Homer L. Sampson,* Roentgenographer of the Trudeau Sanitarium, Saranac Lake, N. Y. Cloth, Price $4.00. 304 pages with 112 illustrations. Philadelphia and New York: Lea & Febiger, 1926.

This volume is the first of a series of monographs from the staff members of the Trudeau Sanatorium, and represents the results of many years of research "along one of its lines of thought." The contents of the book follows closely along the lines of investigation as indicated by the title. It thoroughly reviews the literature on the subject of intestinal tuberculosis and sums up the experiences and observations of over a

quarter of a century at the Trudeaux Sanatorium. The bibliography appended at the end of the book is comprehensive and indicates the meticulous literary labor that went to make up the study of this problem. Of the eighteen chapters that compose the text of this scholarly monograph, only wo chapters are devoted to treatment. The various measures that have heretofore been considered efficacious in the treatment of the different phases of this problem are considered at some length. The discussion includes a review of the value of medication and radiation therapy and the limitation of each is concisely indicated. While no specific form of treatment has arisen out of this study the favorable role played by natural sunlight and artificial ultraviolet radiation is emphasized.

It is the authors' opinion that "the ultraviolet rays and natural heliotherapy frequently relieve the symptoms and bring **about recovery.** Inasmuch as a few cases recover without treatment, judgment of their true value is difficult. They should be used in all cases whether or not treated surgically.'

On the other hand "when the deserved results are not obtained by heliotherapy, roentgen-ray treatment of the intestinal tract should be carefully given or other measures employed." Those who have studied treatment of intestinal tuberculosis and have observed the effect of the various measures employed cannot help but hold a more positive opinion as to the value of helio, quartz, or carbon arc therapy. Checking the authors' personal observations against those published in the past by other competent observers one cannot help but sense an attitude of conservatism that is out of proportion to the known facts. Sunshine and ultraviolet when properly administered come closer than any other remedy as a specific in the treatment of various phases of intestinal tuberculosis.

Here is a book that embodies all of the outstanding facts on the subject. The subject matter is logically and conservatively presented. One feels that every opinion has been leisurely weighed before it was incorporated as a part of the text of this scholarly monograph. This book is highly recommended.

JAHRESBERICHT RADIOLOGIE (Annual Bibliographic information on Radiology.) Bibliographisches Jahresregister Des Zentralblattes Due Die Gesamte Radiologie. Edited by *Dr. K. Frik,* Berlin. First edition, information for the year 1926. Berlin. Verlag. Von Julius Springer, 1929.

This volume is a bibliography of the outstanding work on photo and radiologic subjects published all over the world during the year 1926, under the editorship of Dr. K. Frik of Berlin. The volume should be of value to students of Radiology and writers on scientific subjects. It includes studies and reports on all of the energies from that of infra-red to gamma radiation. As a source book this volume is highly recommended.

INTERNATIONAL ABSTRACTS

Motility of the Gastro-intestinal Tract During Calcium Deficiency and Under the Influence of Ultraviolet Rays. T. Vacek. Cpt. Rend. des Seances de la Soc. de Biol., Vol. 98, 12, 1928.

Ultraviolet irradiation, lasting a short period of time, of the longitudinal musculature of the gastro-intestinal tract causes a marked increase in tonus, even bringing about a contraction of the musculature. A longer exposure (60 minutes) causes a permanent increase in tonus in that the rythmic movements of the muscular wall are decreased. After irradiation the tonus does not return to its original value, but remains increased and motility becomes less, until it disappears entirely. The calcium salts are indispensable for normal rhythmical motility of smooth musculature. A decrease or total removal of these salts from the diet causes a slow but gradual decrease in tonus of the longitudinal fibers of the intestinal tract. The muscular movements are also decreased, until they cease entirely. Smooth muscle which loses its tonus as a result of calcium deficiency reacts in the same way to ultraviolet irradiation as does normal muscle. Only after a long duration in a calcium deficient medium, the reactivity of the musculature disappears. The reaction is still distinct even after a four hour duration in a calcium deficient medium. Thus ultraviolet rays can only partly substitute for calcium deficiency.

The visible rays, without ultraviolet rays, can under certain conditions, cause a lowering of smooth muscle tonus. The conditions required are a strong source of light and good muscle tonus.

On Transcutaneous Bath Therapy with Especial Reference to Ischias. A. Laquer and E. Gruner. Deutsche Med., 54, 38, 1928.

The authors have had remarkable success in over 80 cases of ischias, with the transcutaneous bath therapy. In this paper eight cases are reported which had been refractory to other methods of treatment and which

had been definitely relieved by the transcutaneous bath therapy.

The technic consists in the administration of a complete bath for about 10 minutes, the temperature of the water being gradually increased to 35-40 degrees. When this temperature is reached the transcutaneous preparation is added without stirring. After the patient remains for about 10-15 minutes longer in the bath, a one-half hour packing completes the therapy. Immediately after the addition of the preparation, a transitory chilly sensation is followed by a pricking of the skin, which is intensified by the subsequent packing.

In genuine ischias there are rarely failures with the treatment. The failures almost always occur in cases in which the general condition (f.i. nervous irritability) or where the hypersensitivity of the skin prevents the treatment from being carried out.

The mechanism of the action of the transcutaneous baths consists in a combination of thermic stimulation and chemical skin stimulation. The gradually heated complete bath with the subsequent sweat packing forms the thermic stimulation; a very intensive chemical skin stimulation is caused by the addition of the preparation to the bath. This skin stimulation is made manifest, subjectively, by a very strong sensation of burning in the skin and, objectively, by a more or less intense skin hyperemia during the packing following the bath.

The authors have also had success with the method in subchronic and chronic cases of joint rheumatism and other arthritides and also in arthritis deformans, from which it is concluded that the indications of the treatment should be extended The authors have not observed any kidney complications nor loss in weight as a result of the treatment (not more than 3 baths are given a week). The contra-indications to the treatment are limited to great general debility, intense nervous irritability, and considerable disturbances in the circulatory system. On account of the irritation of the skin, eczema, psoriasis, etc, as well as tendencies urticaria, are to be considered before employing the procedure. The treatment may be carried out at home if the patient has been thoroughly informed in the method.

Treatment of Laryngeal Tuberculosis by Ultraviolet Light Produced by High Frequency Currents. J. Morin and M. Aubry. Ann. Mal. Oreille, 47, 1928.

A suitably bent quartz electrode, containing mercury and connected with a Oudin resonator, emitting ultraviolet rays which are generated by high frequency current, is placed in direct contact with the laryngeal mucous membrane. Controlling it with the mirror, the quartz tube is directed in such a way into the larynx, so that it comes in contact with the epiglottis and touches the vocal cords with its outer ends. As soon as the current is conducted over the tube, ultraviolet rays are generated, which are distributed over the entire larynx. In addition, however, numerous small sparks are observed between the tube and the laryngeal mucous membrane, which are absolutely painless and which do not produce any uncomfortable faradic currents, on account of the high frequency of the apparatus. The sparks are cold and do not burn the mucous membrane. If they are unusually strong they may cause a white, superficial harmless eschar, which, however, may give rise to an uncomfortable difficulty in swallowing several hours later. With calm patients, after careful anesthesia, a duration of thirty seconds is given, then the apparatus is turned off for a moment to rest the patient, and another thirty seconds is administered. This treatment can be repeated four or five times during a single session, so that there is a combined irradiation time of two or three minutes. At the first session thirty seconds is sufficient, and at the following sessions this is extended to about four or five minutes. Between sittings there is an interval of one to two weeks. In addition to the local reaction, general reactions are observed at times. The experience gained thus far does not permit of a definite conclusion to be reached on the value of this new method of treatment. The authors are, however, convinced that ultraviolet rays generated by high frequency currents will be substituted for all methods of natural and artificial sun irradiation.

A New Treatment of Lipomata by Bipolar Diathermocoagulation. Bordier and Olivier, Archives d'Electricite Medicale et de Physiotherapie Du Cancer.

The treatment is not applicable to tumors which are larger than a quarter of an egg. If they are larger they should be treated surgically. After local anesthesia has been administered, two needles are placed in the tumor. The needles are insulated up to a quarter of an inch from their points, thus preventing the skin from coagulating. A current is passed between the two needles and is stopped when it is judged that the diathermocoagulation is sufficient, which can only be learned from experience. After the session, a vaseline dressing is applied. Usually resorption occurs, sometimes the coagulated lipoma looks like a furuncle. (In such cases wash with oxygenated salt solution.) Usually at the end of a month the tumor has disappeared. If a part has escaped the action of the current, a light session of diathermocoagulation is again administered to its surface.

The authors have constructed a special sleeve bearing the two needles.

Heat Treatment of Streptococcus Infections. Bruno Mendel, Frida Strelitz, and Milly Bauch. Klin. Wchnschr. 2, 1928.

The authors report experiments purporting to show that various parasitic cells living in the animal body are more sensitive to heat than normal cells. They have determined the time required for given degrees of temperatures to kill cancer cells, and how long certain temperatures must act on given bacteria in order to render them harmless to the body. These experiments form the basis of the author's heat therapy. On the basis of their animal experiments, the authors make

some therapeutic suggestions. They suggest the application of heat therapy in streptococcus infections of human beings. This is particularly recommended for panaritium. The heat treatment includes a method for raising the body temperature for a long period of time. The authors will report on this in the future.

Contributions to the Problem of the Effect on Metabolism of Ultraviolet Irradiations. A. Lippman and H. Volker, Klin. Wchnschr., 7, 5, 1928.

Metabolism is only very slightly affected. It rises on an average of 10 to 18 per cent and is independent of the dose administered. The rise in metabolism lasts only a short time and only 30 minutes after irradiation low values are again obtained. The administration of large doses of iodine also causes a rise of only very short duration. Non protein nitrogen and blood sugar show no changes. A slight fall in blood sugar was observed in three cases of diabetes.

Superimposed, Intensive Irradiation of Lupus Vulgaris With Ultraviolet Light. Werner Jadassohn. Klin. Wchnschr., 2, 1928.

The method consists of a rapid succession of ultraviolet irradiations, best done with Kromayer compression, and the artificial sun lamp is used only when the Kromayer cannot be applied. The treatment is continued until an excessive reaction occurs with blister and crust formation. The inflammation resulting from the light treatment should not be treated by any ointment or other method. The intervals between irradiations were gradually made shorter and shorter during the two years in which this method was applied, and the most recent interval was only two days. Before the superimposed irradiation, the crusts are to be removed and the skin flaps trimmed with scissors. The number of treated patients is still small, nevertheless the success in each case is very encouraging.

What the Physician Should Demand in a Diathermy Apparatus. J. Kowarschik, Med. Klin., II, 1928.

We do not as yet possess an ideal diathermy apparatus. This can be deduced from the fact that the various firms construct different kinds of apparatus, claiming for them various advantages. Kowarschik then discusses what a dithermy apparatus should yield. One should be able to administer general diathermy with current strength of 2.0 to 2.5 amperes. The diathermy current must be free of a faradic feeling, which is usually a shortcoming of the smaller apparatus made for diathermocoagulation. In the latter one should use care that the low frequency oscillations, which probably arise in the generating circuit, should be kept away from the patient by condensors arranged in series. The spark gaps can be considerably altered by substituting tungsten electrodes for silver electrodes. Tungsten, on account of its high melting point, is less affected by the electrical sparks than silver. The tungsten spark gap must be cleaned now and then. The story of its indestructability is just a fairy tale. The spark gap must be visible and easily accessible. The current circuit of the patient should be divided into two or more parts. The physician should be able to measure the current in both circuits, for which two amperemieters are necessary, or one which may be interchangeably connected with each part of the current circuit. The author then discusses the inadequacy of the large diathermy apparatus with which four ar more patients are to be treated at the same time.

Radiologic or Operative Treatment of Cancer of the Uterus? Dr. J. Heyman, Stockholm, Strahlentherapie, No. 29, 1928.

The question whether surgery or radiotherapy is better in cases of cancer of the uterus can be answered only through a study of statistics. With a fairly large material and a freedom of recurrence for five years, the author feels that he is in a position to answer the question, at least as far as the cervix of the uterus is concerned.

The author accepts that the average value of surgery of a positive character for carcinoma of the cervix, after a critical study of the cases, can be estimated at 20.2 per cent. At the institute of the author the percentage of successful treatments by radiation reached 20.7. While the difference is not great as far as the figures go, it is pointed out that the circumstances regarding the character of the selected case must be taken into consideration. This selection shows that for the surgical cases 58.6 per cent of the operated cases have been regarded as operable ones, whereas in the author's institute only 26.6 per cent of the treated cases can be so classified. If this difference is taken into consideration the conclusion is permissible that radiation therapy is superior to surgery.

The author admits that a comparison of the two methods for the "pure operable" cases is based on too small a material to justify a definite conclusion, but even on the basis of the limited observations he can see no proof of any kind that surgery could have accomplished more than radiotherapy. The author finally points out that with the advances made in the technics the future promises still better results, especially since a primary mortality has already been eliminated.

As regards cancer of the body of the uterus, study of the statistics of both methods does not allow any definite conclusions, the material being too small and too incomplete for correct valuation.

X-Ray Therapy of Hypertrophy of the Prostate. Dr. R. Oppenheimer, Strahlentherapie, No. 29, 1928.

From time to time the question whether hypertrophy of the prostate is amenable to any form of physical therapy has agitated the minds of urologists and physicians in general. In this contribution Oppenheimer gives us a review of his experience, which is not only interesting but invaluable because the author has

based his conclusions on critical experience with a fairly representative class of material, in an unbiased manner.

Oppenheimer reaches the conclusion that moderate doses of roentgen rays in combination with massage of the prostate, diminish in a large number of cases the phenomena of irritation especially frequency of micturition. But it must not be overlooked that these beneficial results have been observed only in the initial stage of the affection. The treatment, however, does not prevent the further development of the hypertrophy nor can it stop the gradual appearance of chronic urinary retention.

In hemorrhage from the prostate radiation of the gland may be useful. In acute retention small doses have been tried but without any effect whatever, and as regards chronic retention any form of roentgenotherapy has no effect whatever.

The author also considers the application of large doses dangerous when there is a coexisting cystitis.

The author recommends the application of the rays to the perineum, his technique being somewhat like this: A field is radiated for two consecutive days, each treatment is administered with a 33 to 40 per cent HED. dose with filter of three millimeters aluminum. This treatment is repeated only after a pause of three to four weeks when six to twelve radiations are given. Rarely must a suprapubic field be radiated.

(The author's observations coincide with those experienced by the abstractor.

X-Ray Diagnosis of Tubal Conditions by Intra-Uterine Injection of Lipiodol. R. Proust and A. Beclere. (Paris.) Bull. Soci. Nat. Chir., No. 54, 1928.

Proust having had a grave accident with collargol had been unable to make up his mind to inject lipiodol into the uterus, but now is convinced of its harmlessness. Both authors emphasize the value of the method for conservative surgery. Of 70 cases thus examined in the past year 30 had salpingitis, after the acute attack had fully subsided. There was not only not a single accident but not even a rise of temperature or peritoneal irritation, and this in spite of the fact that in 11 cases the lipiodol entered the peritoneal cavity through an open tube. In the cases of salpingitis the examination gave important information concerning the therapy. In four cases which showed bilateral permeability operation proved unnecessary, and this was particularly important in one patient who had passed a severe puerperal infection resulting from retention of placental tissue. In spite of curettage, fixation abscess, perimetritis and salpingitis, both tubes were shown in the roentgenogram to be open and permeable. In eight other cases the x-ray picture showed that one tube was permeable and the other occluded. *Per Contra* the x-ray showed impermeability of one and often of both tubes when the clinical examination revealed no diseases of the adnexa, due probably to a gonococci process which had produced no symptoms.

In order correctly to interpret the x-ray findings it is necessary to make a control picture twenty-four hours after the injection and then compare the two pictures.

In 700 lipiodol injections in France and many others reported elsewhere not a single accident occurred. As regards the sole case of death following an injection of umbrenal, it could not be ascribed with absolute certainty to the contrast agent, as the resulting pelvic peritonitis may have been due to some other cause.

Ways in Which Emotion can Effect the Digestive Tract. W. C. Alvarez, J. A. M. A., 92: 1231-1237, Apr. 13, 1929.

Some cases are reported in which there were signs of a psychic increase in intestinal tone and activity. Much experimental evidence has been gathered to show that emotions can stimulate or inhibit not only peristalsis, but also the flow of the salivary, pancreatic and gastric juices. Normally, the sight, smell and thought of food prepare the digestive tract for the work it has to do. Not only mental, but also physical fatigue can interfere with this process.

A syndrome is described in which most of the sphincters of the body are hypersensitive and hypertonic. It is suggested that more effort be made to warn patients against eating when absent minded, mentally upset or greatly fatigued.

Not infrequently some article of food gets the blame for an attack of indigestion when the trouble was really due to the fact that a large meal was put into a stomach that was not ready to receive it.

It is suggested that after operations, when a return of peristalsis and intestinal tone is desired, it would be logical to give the patient some tasty morsel of food, preferably meat.